ROOT SYSTEMS OF IMPORTANT RANGE PLANTS OF THE BOISE RIVER WATERSHED

A Catalogue

of species excavated by

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TABLE OF CONTENTS

	Page
Introduction.....	1
Class One - Species with fibrous root systems.....	4
Class Two - Species with semi-fibrous root systems.....	8
Class Three- Species with semi-tap root systems.....	9
Class Four - Species with tap root systems.....	11
Studies of the roots of plant communities by means of bisects	12

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Introduction

In the management of important range-watershed areas of the West a knowledge of the root systems of important plants is urgently needed in the study of the ecological relationships of the underground parts of range plant communities, and to indicate the relative soil holding ability of the principal species of the region. In order that such information for the Boise River watershed in southwestern Idaho might be secured a study of the root systems of range plants of the area was initiated in 1932.

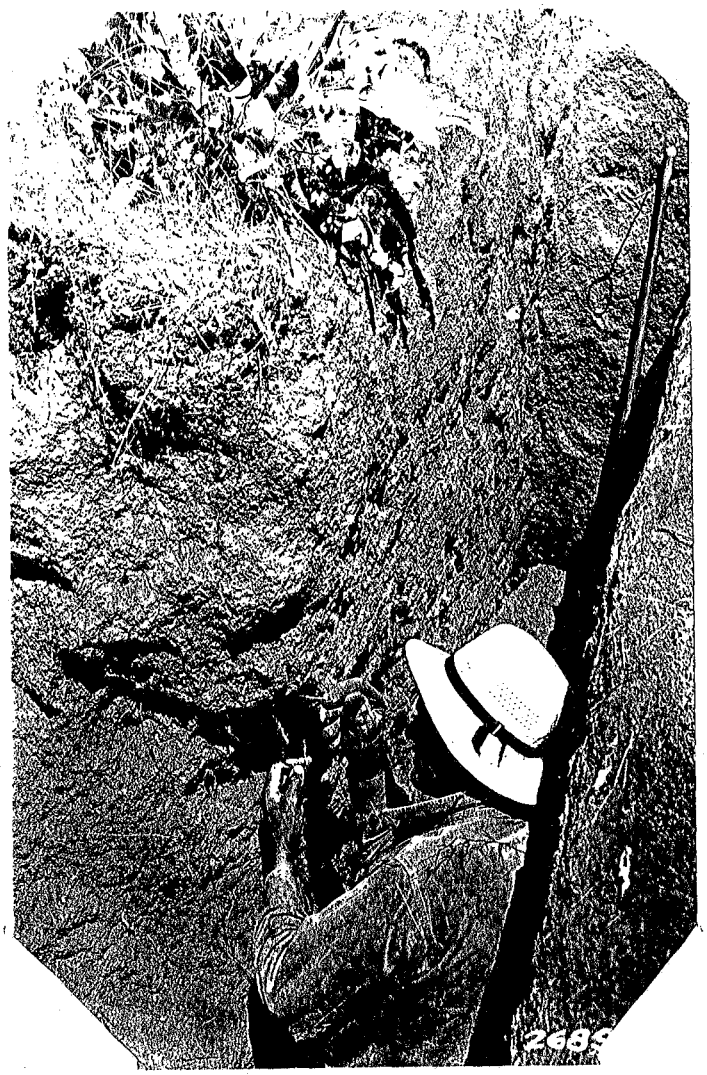
L. E. Spence, in collaboration with the Intermountain Forest and Range Experiment Station, planned and conducted this study with the assistance of special field men and CCC enrollees. Mr. Spence has prepared a manuscript for publication summarizing his findings, but due to the cost of reproducing drawings in the journals, only a few root systems could be shown in his paper. It therefore was deemed desirable to gather all of the drawings together in this catalogue which has been prepared for the use of workers in the field of plant-soil relationships.

Methods of Study

The technique used was the same as that described by Weaver 1/ except for deviations necessary to meet conditions on the ground.

1/ Weaver, John Ernst. Root development of field crops. McGraw Hill, 1926.

Trenches were dug on the contour of slopes with the upper face of the trench about 15 cms below the plants to be excavated. An ice pick was used to expose the roots, the excavation being extended through the soil profile to a face 15 cms beyond the crown of the plant, thus providing a root zone 30 cms in thickness for study purposes. The exposed roots were drawn to scale as excavated.



An excavator in a work trench exposing the root system of a specimen of Balsamorhiza sagittata.

Because of the great number of roots of the perennial grasses, and in order to give a more legible picture of their root patterns, only about 25 percent of the roots of each perennial grass plant are shown in the sketches.

In all, 52 species were excavated and drawn to scale. A typical root system was selected for each species from the several specimens excavated. Whenever significant variations were encountered in the root system of any species due to differences in either aspect or elevation of the site, a typical specimen was selected from each environmental condition. The patterns of the root systems of all species studied, considered as a single group, formed a fairly continuous series from the single tap of some of the annual herbs to the profusion of fibrous roots of Carex geyerii, with all possible gradations between these two extremes. For the purpose of discussion, however, it was possible to segregate the root systems of the individuals excavated into four rather distinct classes.

Class One - Species with Fibrous Root Systems

This class includes those species having a concentration of fibrous roots in the upper 3 cms of soil from which longer roots spread laterally and downward, rather completely permeating the upper 30 to 40 cms of surface soil. Eleven species, all of which are grasses or sedges, were classified in this group as listed below:

Annuals

Bromus tectorum

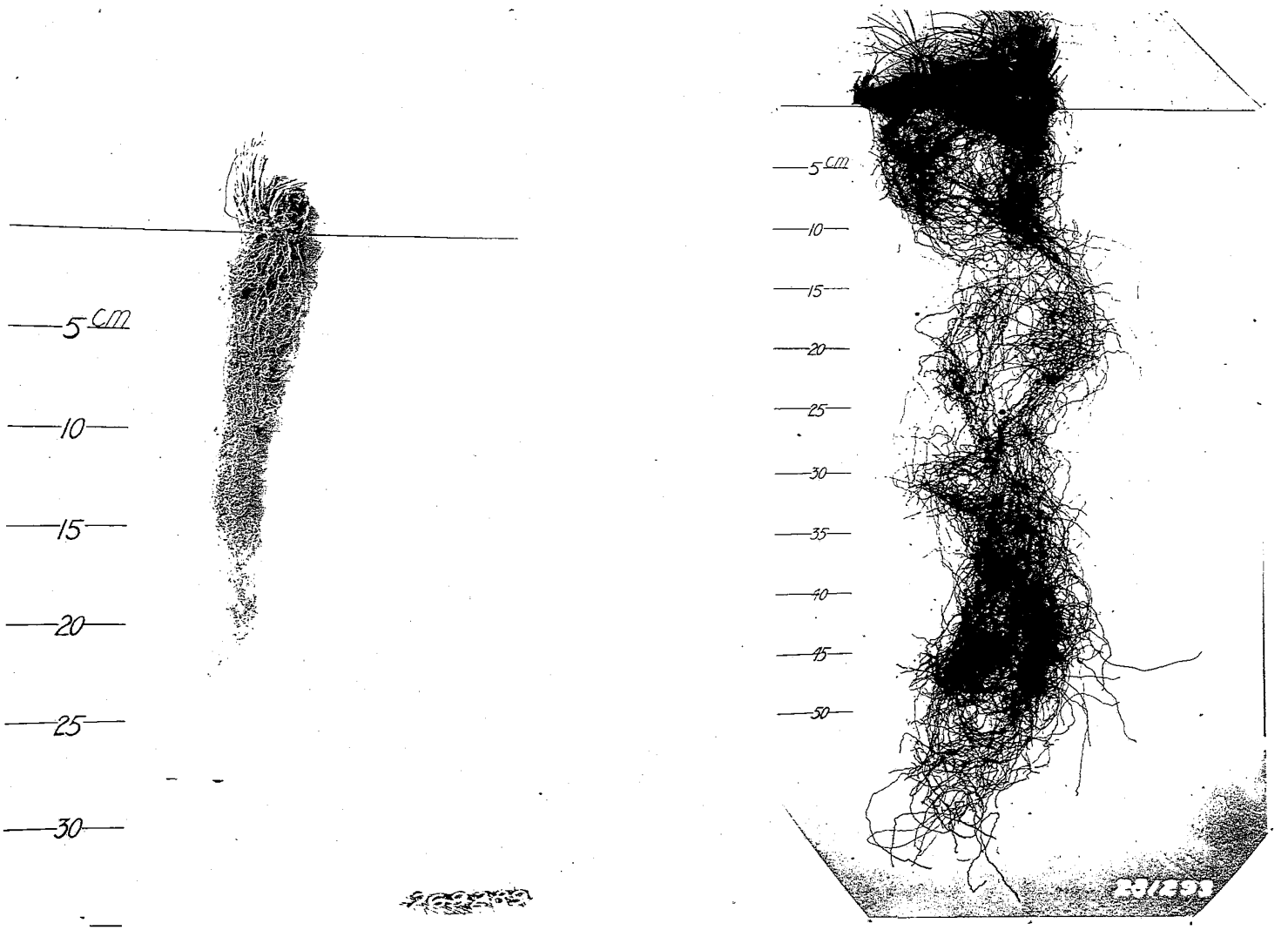
Perennials

Agropyron inerme	Melica bella*
Bromus marginatus*	Poa secunda
Carex geyerii	Sitanion hystrix*
Festuca idahoensis	Stipa columbiana*
Koeleria cristata	Stipa lettermani

The average depth of penetration and number of roots per plant vary somewhat from one fibrous species to another. Longevity and size of the aerial parts of the species appear to account for much of this variation. Annual grass species such as Bromus tectorum produce only about 7 roots per plant which penetrate the soil to a depth of 30 to 40 cms. Short-lived perennial grasses such as Poa secunda produce considerably more roots but penetrate only the upper 40 cms of soil, whereas the longer-lived perennials studied such as Agropyron inerme, Carex geyerii, and Festuca idahoensis produce a greater number of roots which in most cases penetrate the soil to much greater depths.

* Not drawn

In general, the more robust fibrous-rooted species such as Agropyron inerme and Carex geyerii produce a great number of roots and penetrate the soil to greater depths than their more diminutive neighbors such as Poa secunda and Stipa lettermani. From the standpoint of the number of roots per unit of soil, however, the more extensive root systems of the larger species are probably more than balanced by the greater frequency of occurrence of plants of the smaller species. In this class the relatively large number of roots from small plants is astonishing. Individuals no larger than one centimeter in area commonly produce more than 75 roots.

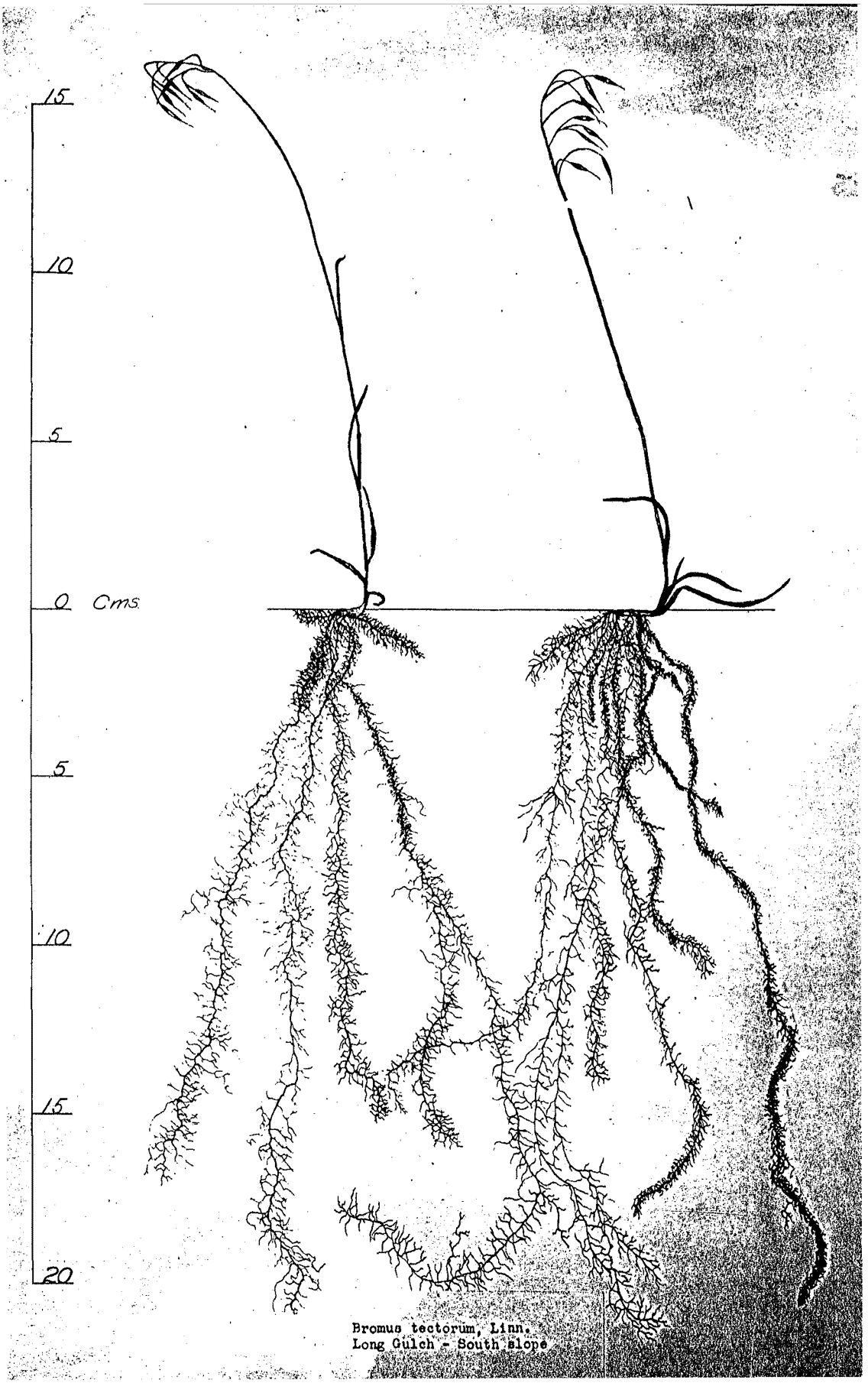


(a) (b)

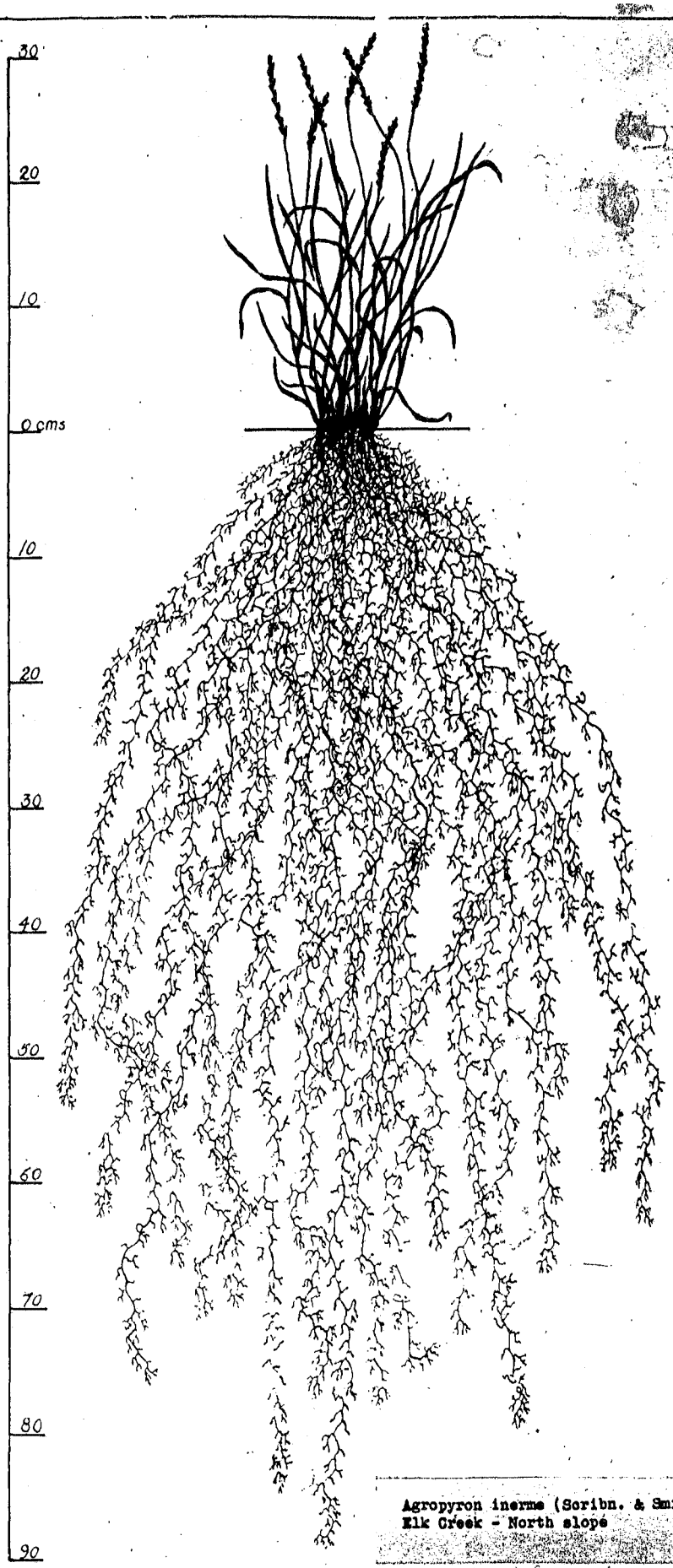
Root systems of (a) Poa secunda and (b) Carex geyerii

(a) (b)

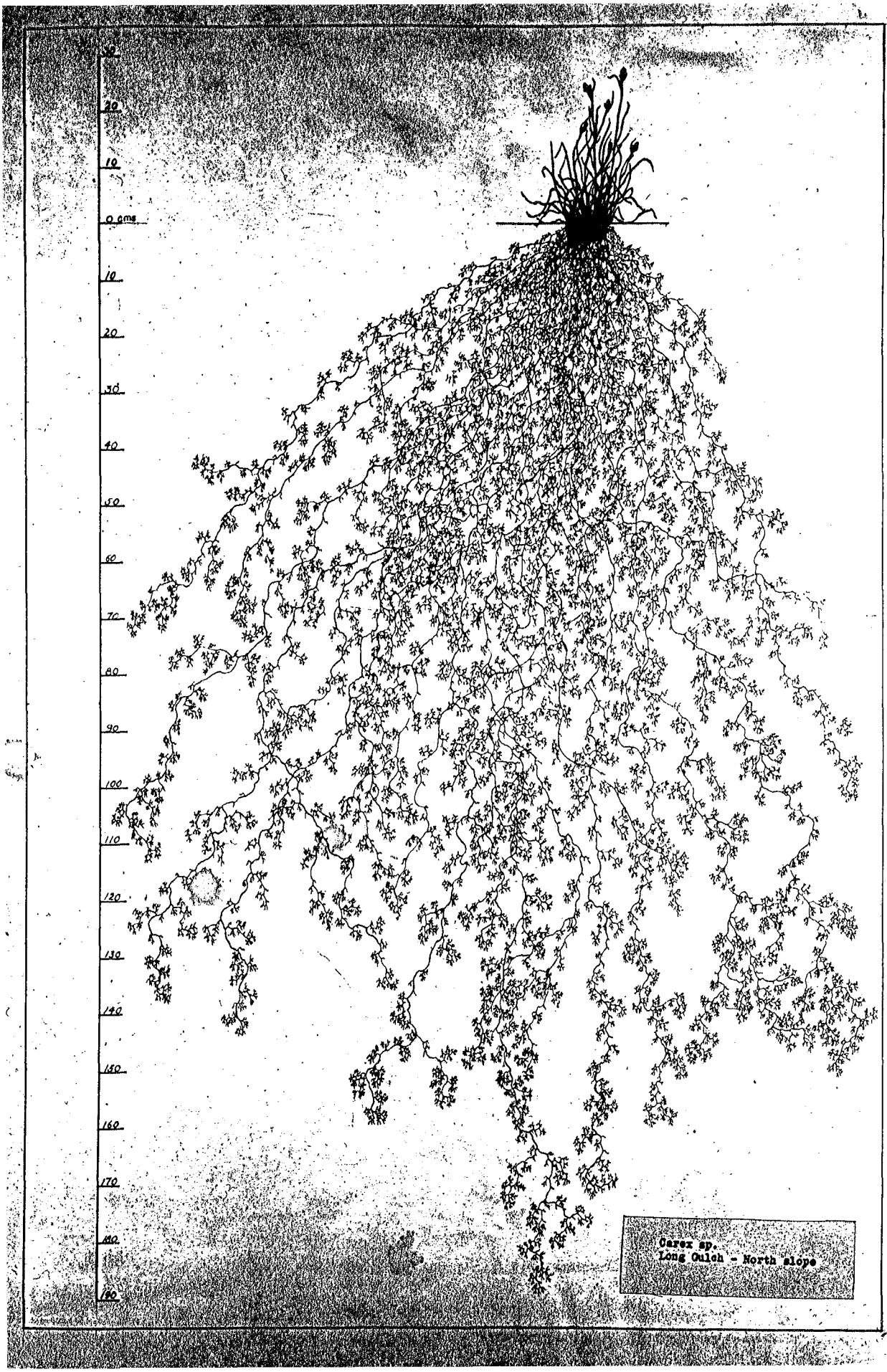
Root systems of (a) Agropyron inerme and (b) Festuca idahoensis



Bromus tectorum, Linn.
Long Gulch - South slope



Agropyron inerme (Scribn. & Smith) Rydb.
Elk Creek - North slope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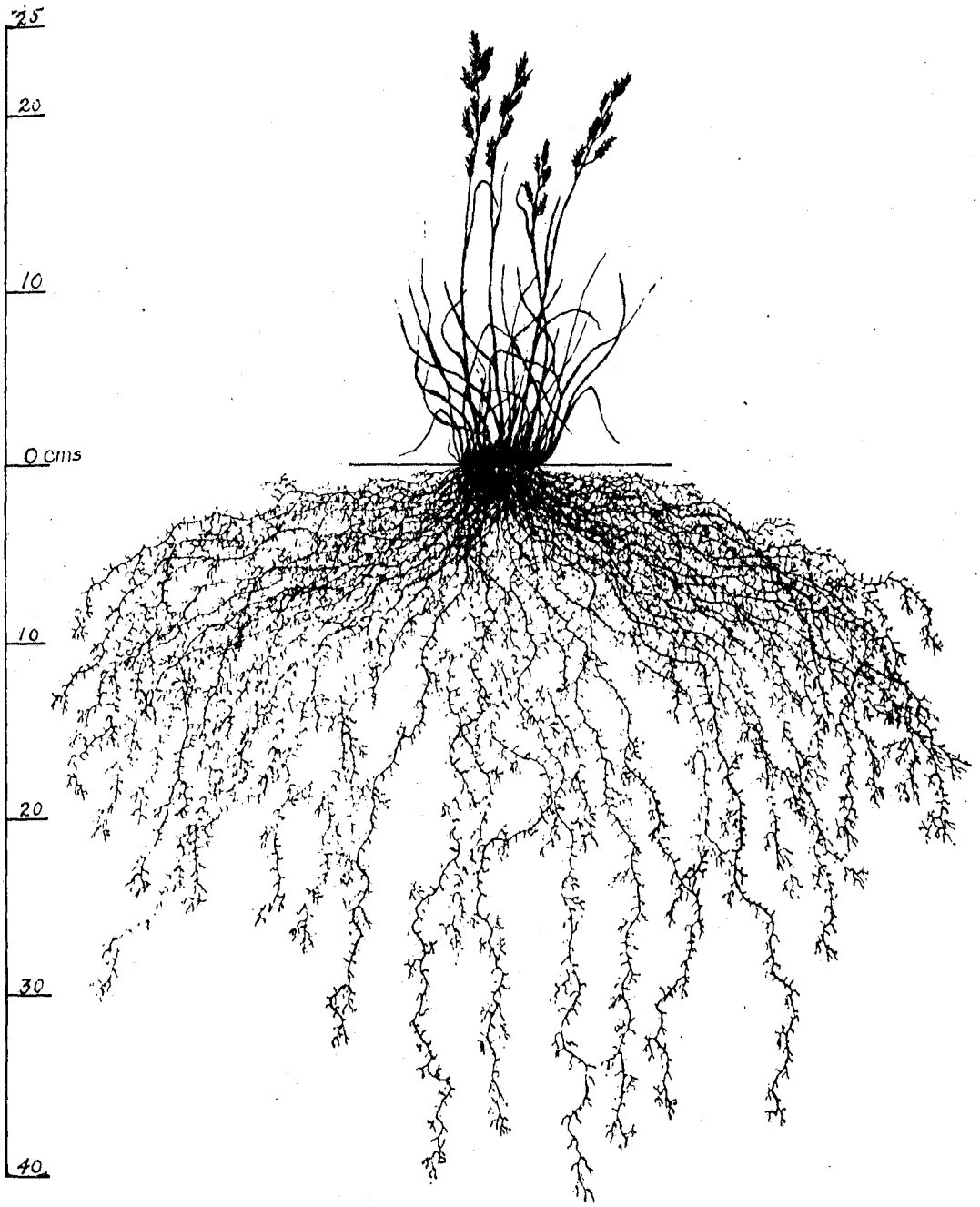
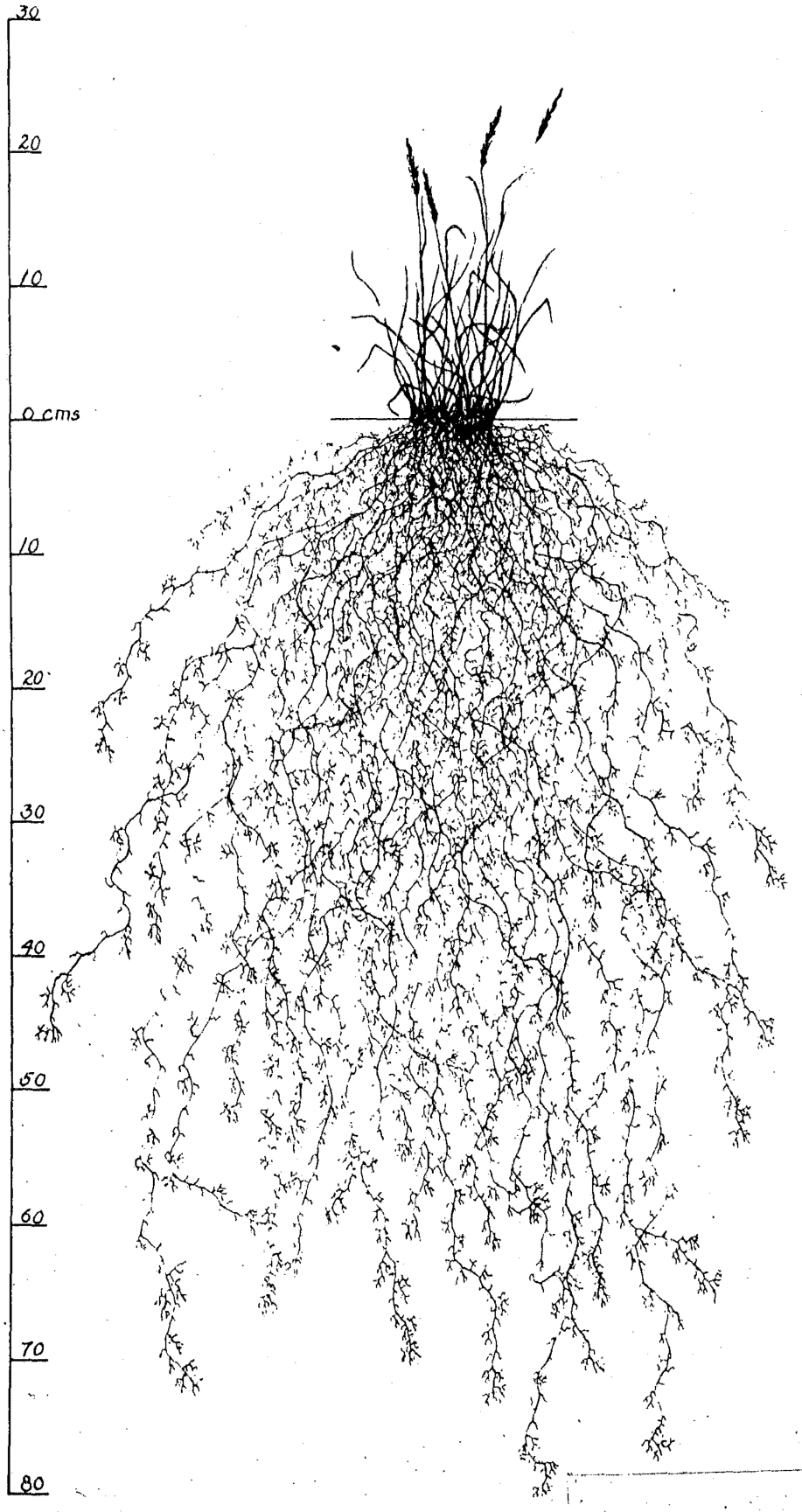
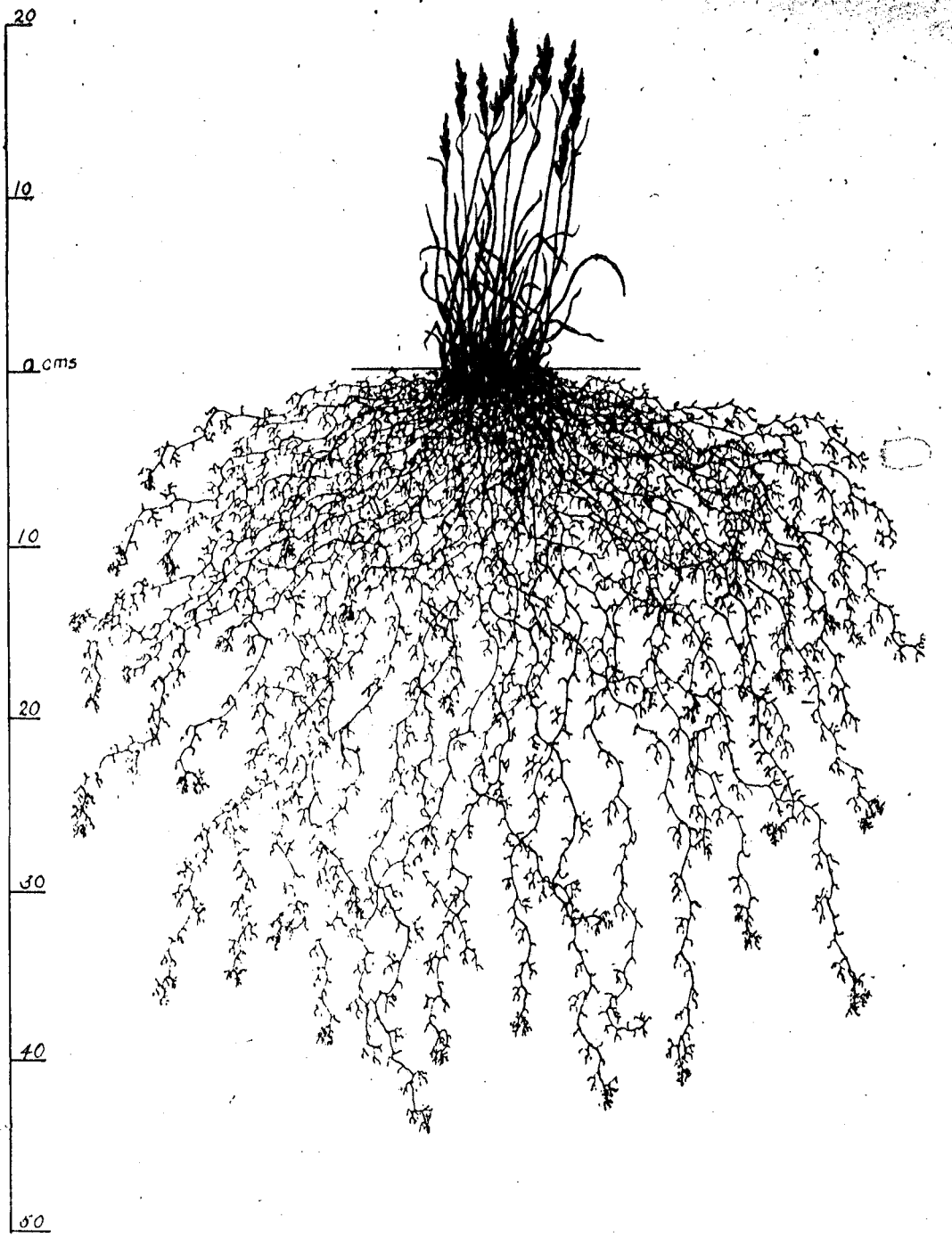
Carex sp.
Long Gulch - North slope



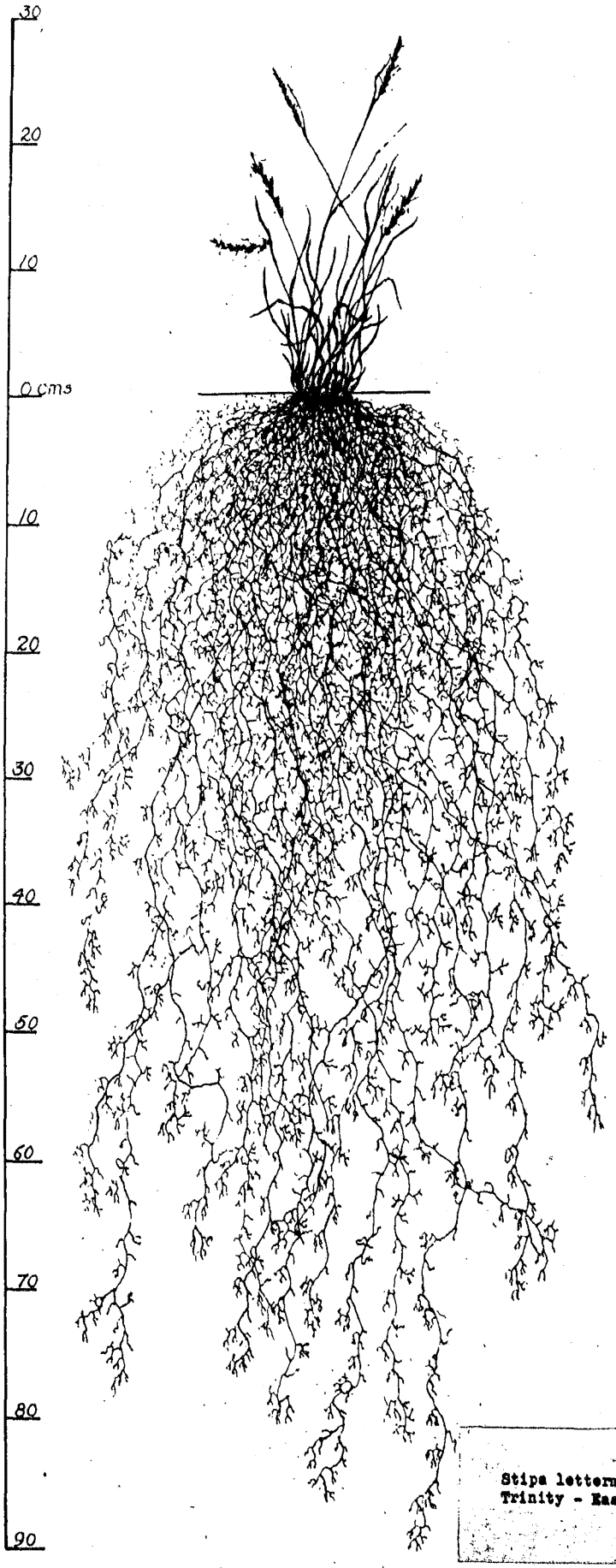
Festuca idahoensis Elmer
Cow Creek - North slope



Koeleria cristata (L.) Pers.
Cow Creek - North slope



Poa sandbergii Vasey
Elk Creek - North slope



Stipa lettermanii Vasey
Trinity - East slope

Class Two - Species with semifibrous root systems

This class includes species having a short, horizontal, tuberous root 1 to 8 cms long from which 5 to 50 lateral roots spread 40 to 60 cms horizontally and from 40 to 190 cms downward. It is characteristic of most of these species to propagate by underground roots. Plants which originate from underground roots may produce new lateral roots while remaining attached to the parent plant. Six species were classified in this group as follows:

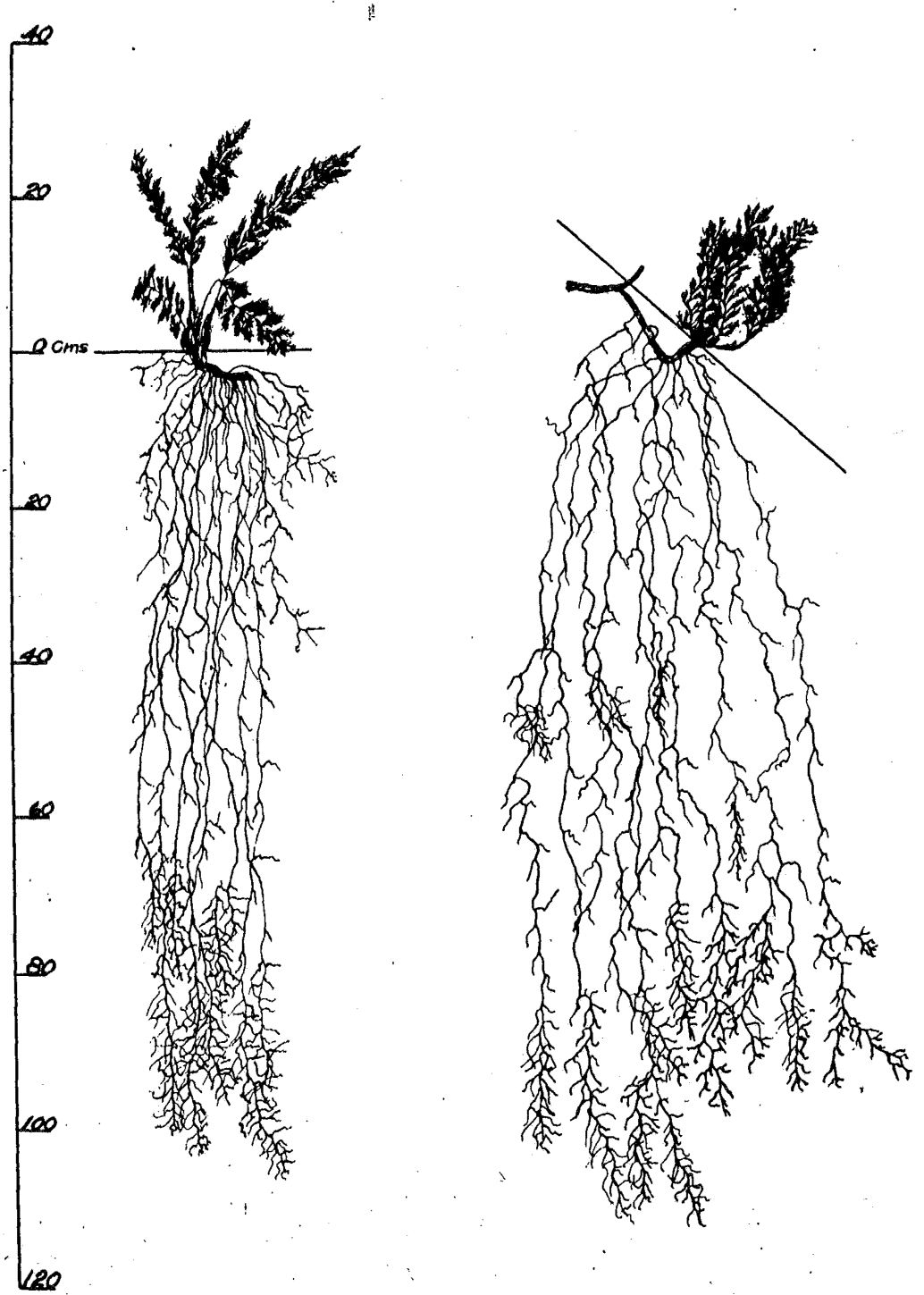
Perennials

Achillea lanulosa	Hieracium scouleri
Aster spp.	Pentstemon glaber
Calochortus eurycarpus	Vicia americana

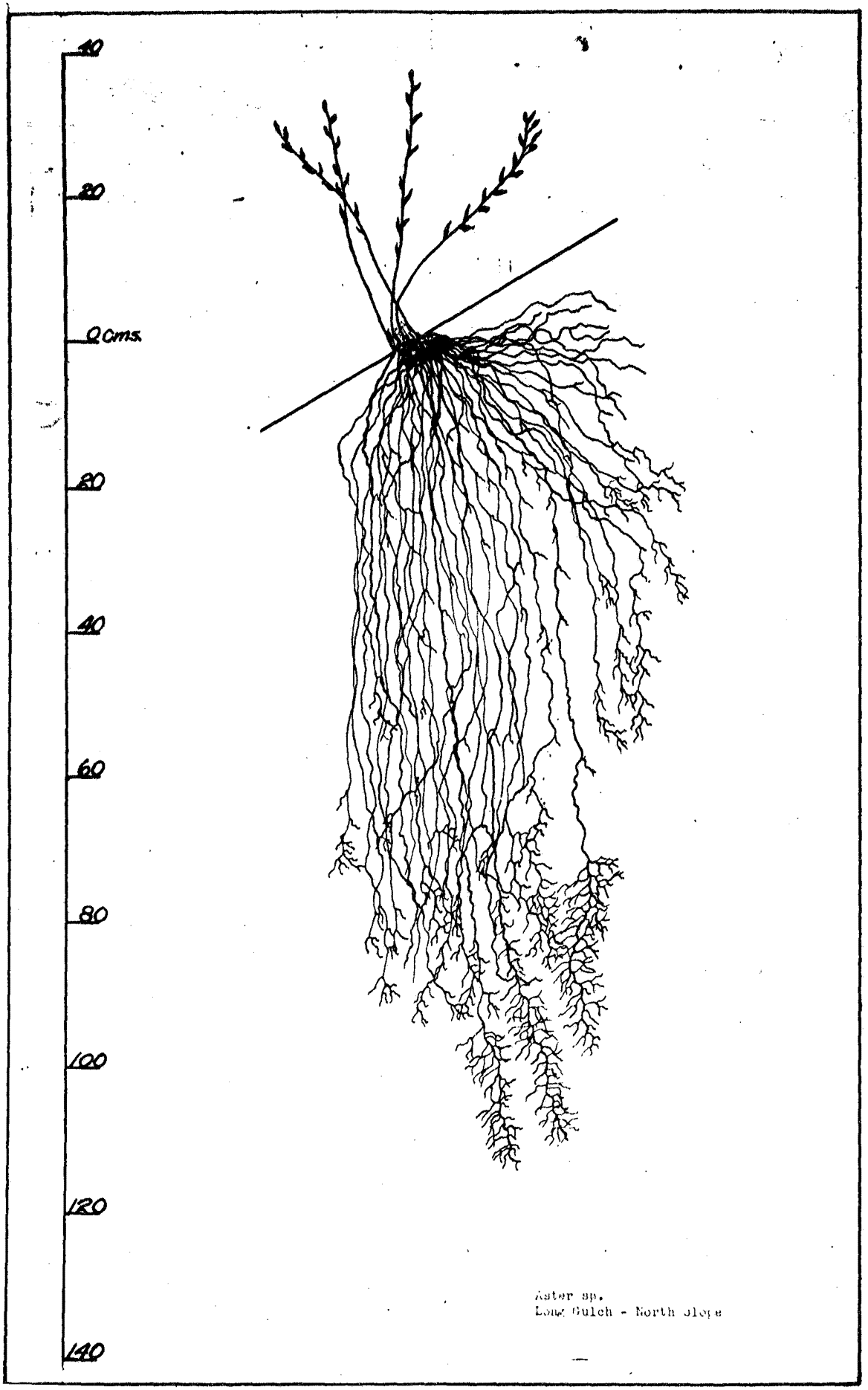
(semifibrous root from underground bulb)

The root systems of the species in the semifibrous class conform to a very definite pattern as did those included in the fibrous class. When compared with the fibrous roots, the semifibrous roots are in general larger in diameter and fewer in number.

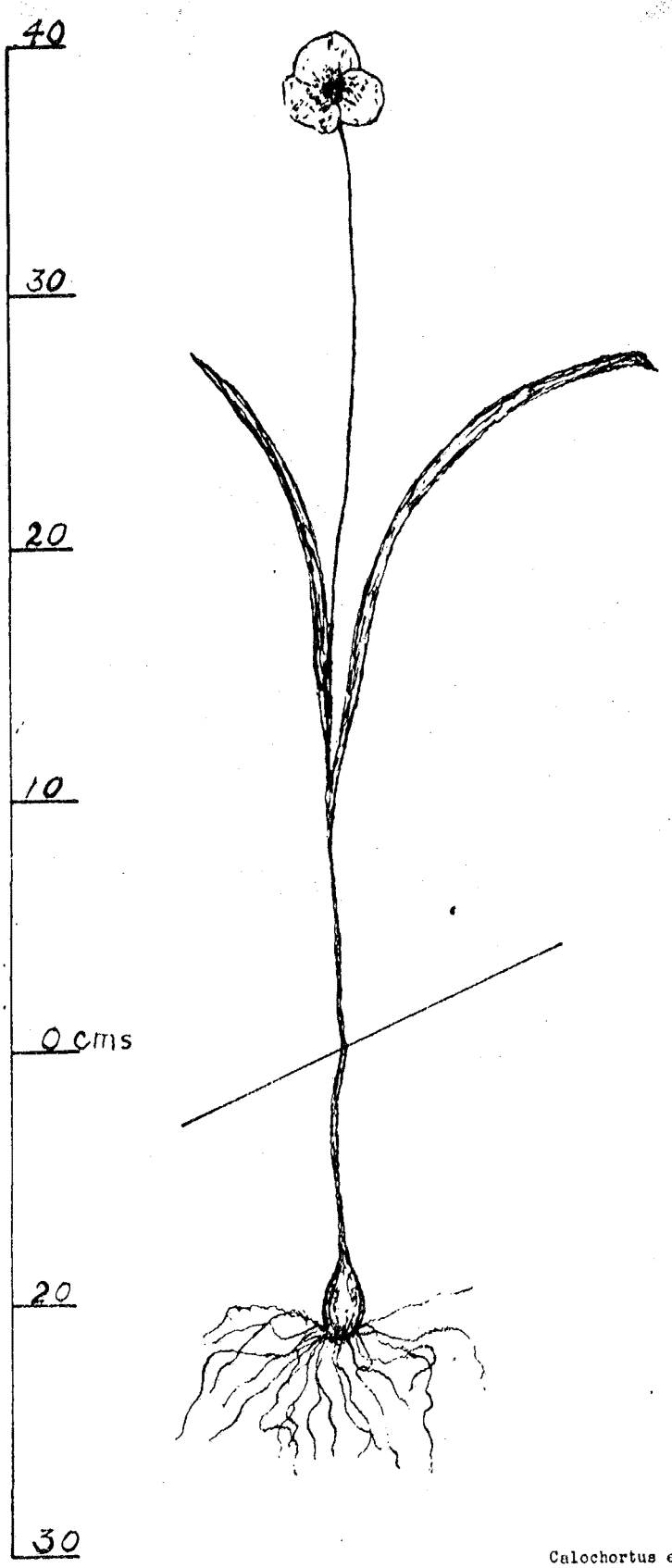
No appreciable amount of variation in the number of roots per plant is shown between species within this class, each species commonly producing from 15 to 40 roots. The depth of penetration, however, varies somewhat from one species to another. Pentstemon glaber and Hieracium scouleri commonly permeate the soil to depths of 160 to 190 cms, respectively, whereas the roots of Achillea lanulosa, Aster spp., and Vicia americana do not commonly penetrate below the 120 cm level.



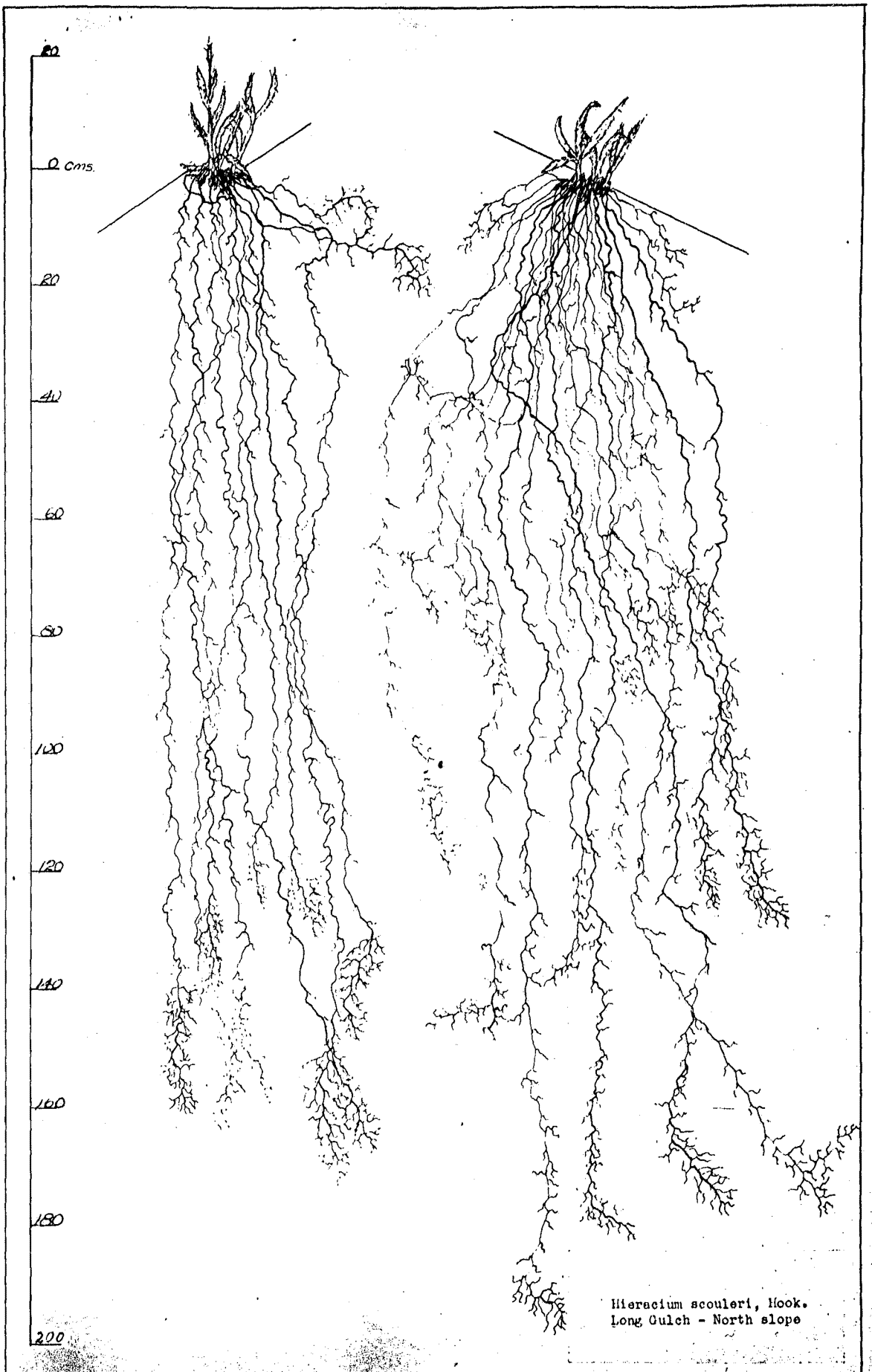
Achillea lanulosa, Nutt.
Long Gulch - North slope



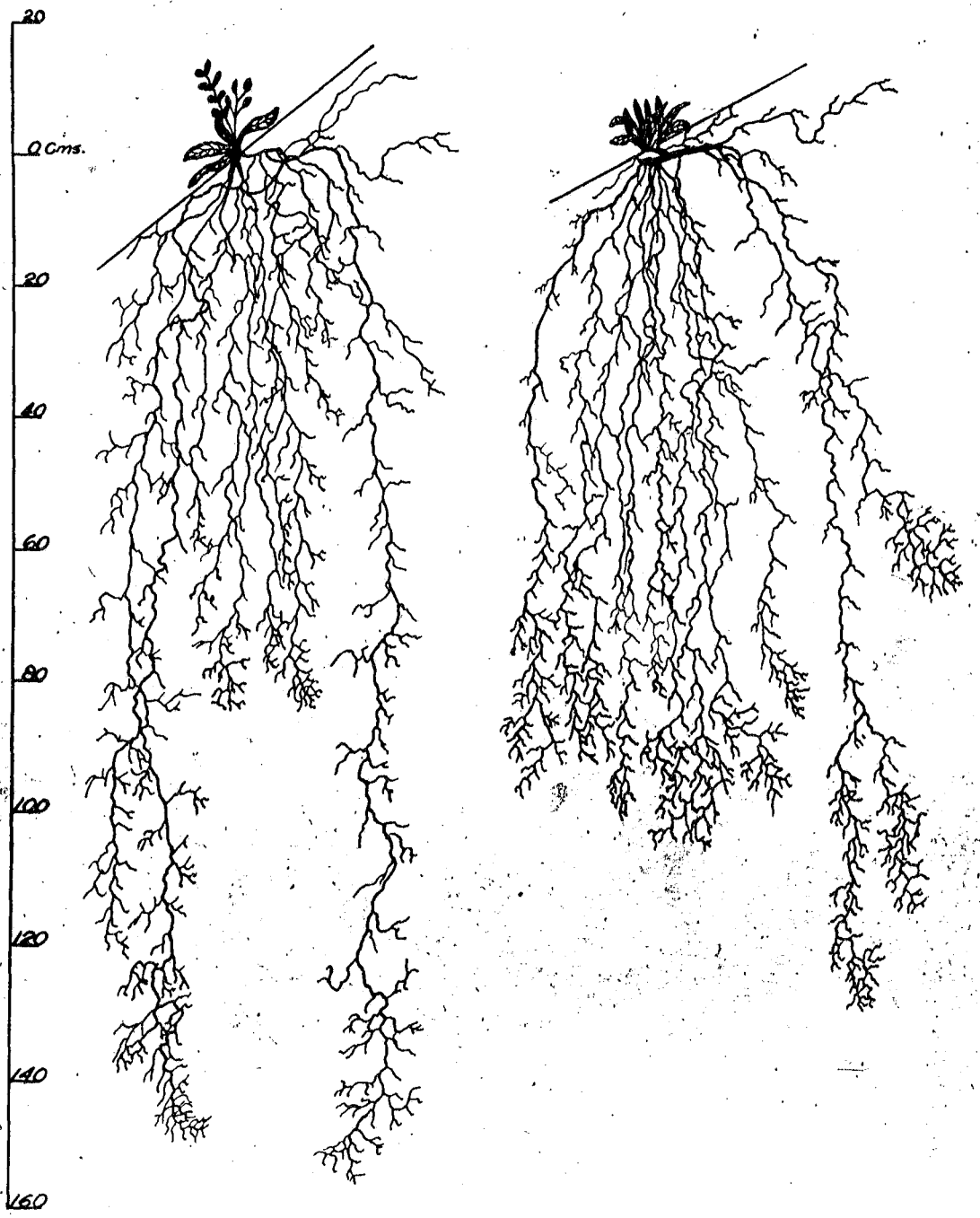
Aster sp.
Lone Gulch - North Slope



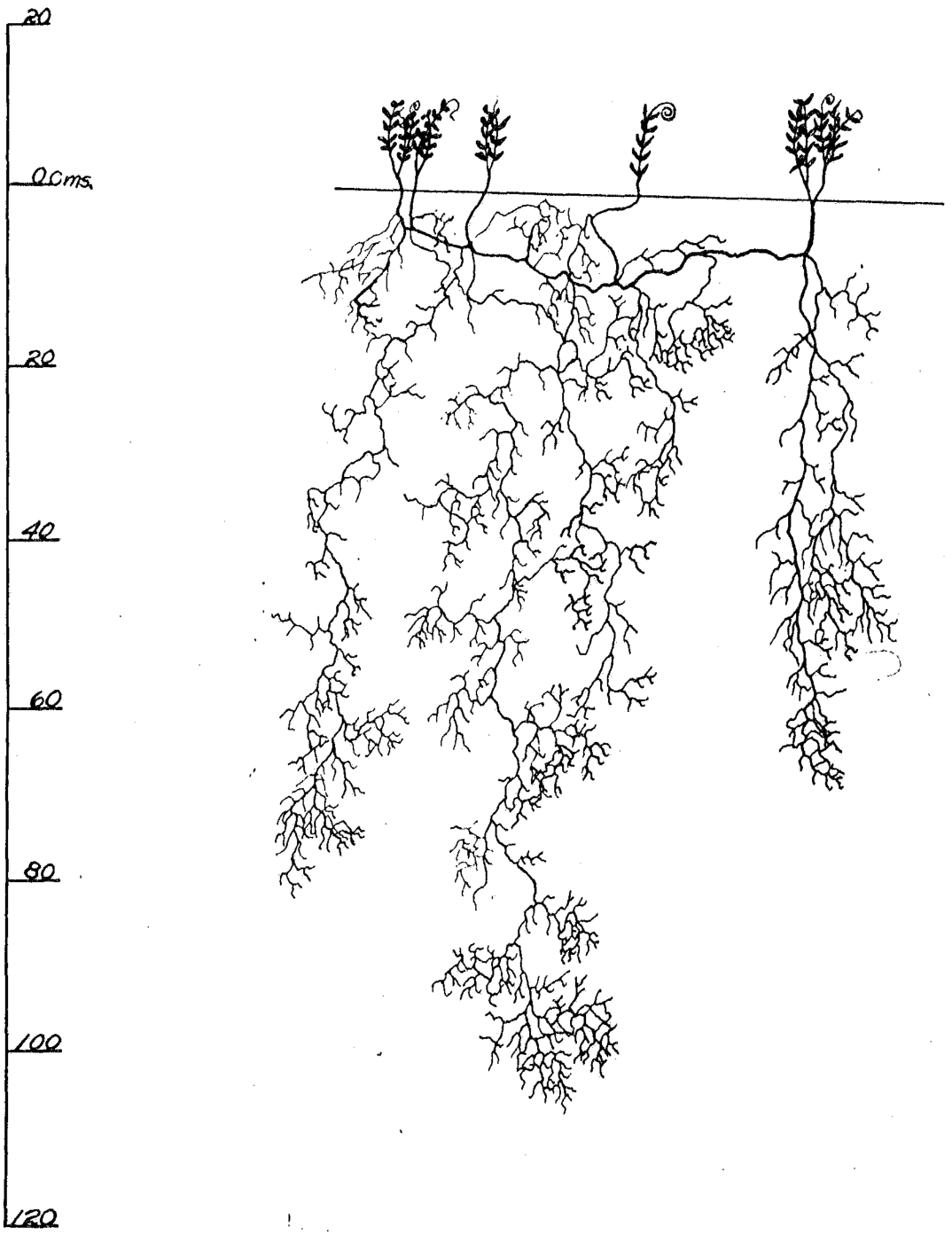
Calochortus eurycarpus, S. Nuts.
Long Gulch - North slope



Hieracium scouleri, Hook.
Long Gulch - North slope



Pentstemon glaber, Pursh.
Long Gulch - North slope



Vicia americana, Muhl.
Long Gulch - North slope

Class Three - Species with semitap root systems

This class includes a wide range of root patterns, varying from a somewhat tuberous type to those within the semifibrous category. A typical semitap root system begins with a small to very large tap root which penetrates the soil from 20 to 100 cms before terminating with a variable number of secondary leaders. In this branching zone numerous leaders are developed of which several may be 1 cm or more in thickness. The latter give rise to an extensive though irregular network of laterals spreading in all directions. Twenty-one species were grouped in this class as listed below:

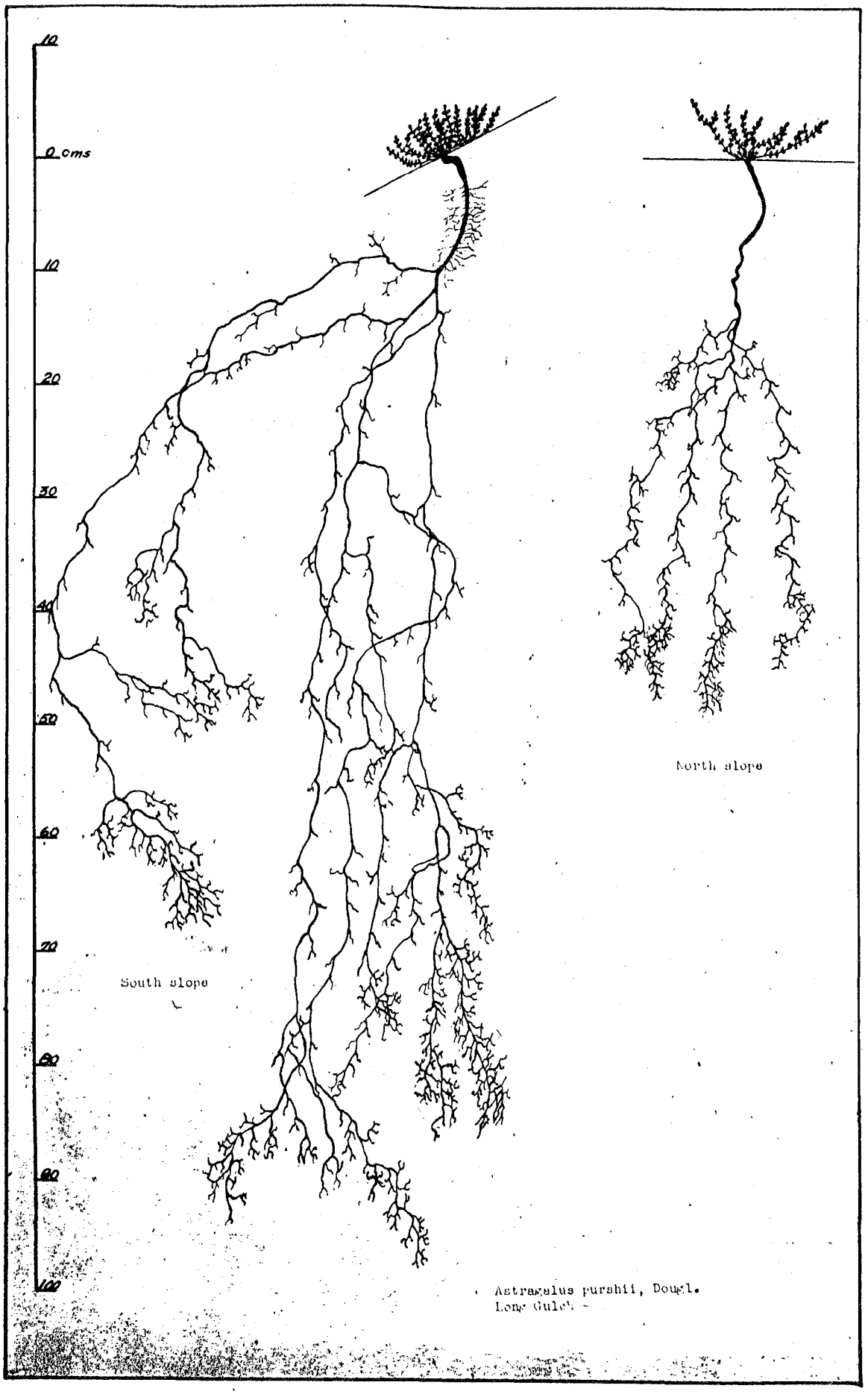
Perennials

Aconogonum phytolaccaefolium*	Lappula floribunda
Astragalus mortoni*	Lithospermum ruderale
Astragalus purshii	Lupinus comatus*
Amelanchier alnifolia	Lupinus ornatus
Balsamorhiza sagittata	Lupinus tenellus*
Clematis hirsutissima	Paeonia brownii
Eriogonum umbellatum	Phacelia heterophylla
Eriogonum heracleoides	Phlox longifolia
Geranium viscosissimum	Potentilla blaschkeana
Heuchera sp.	Prunus melanocarpa
	Wyethia amplexicaulis*

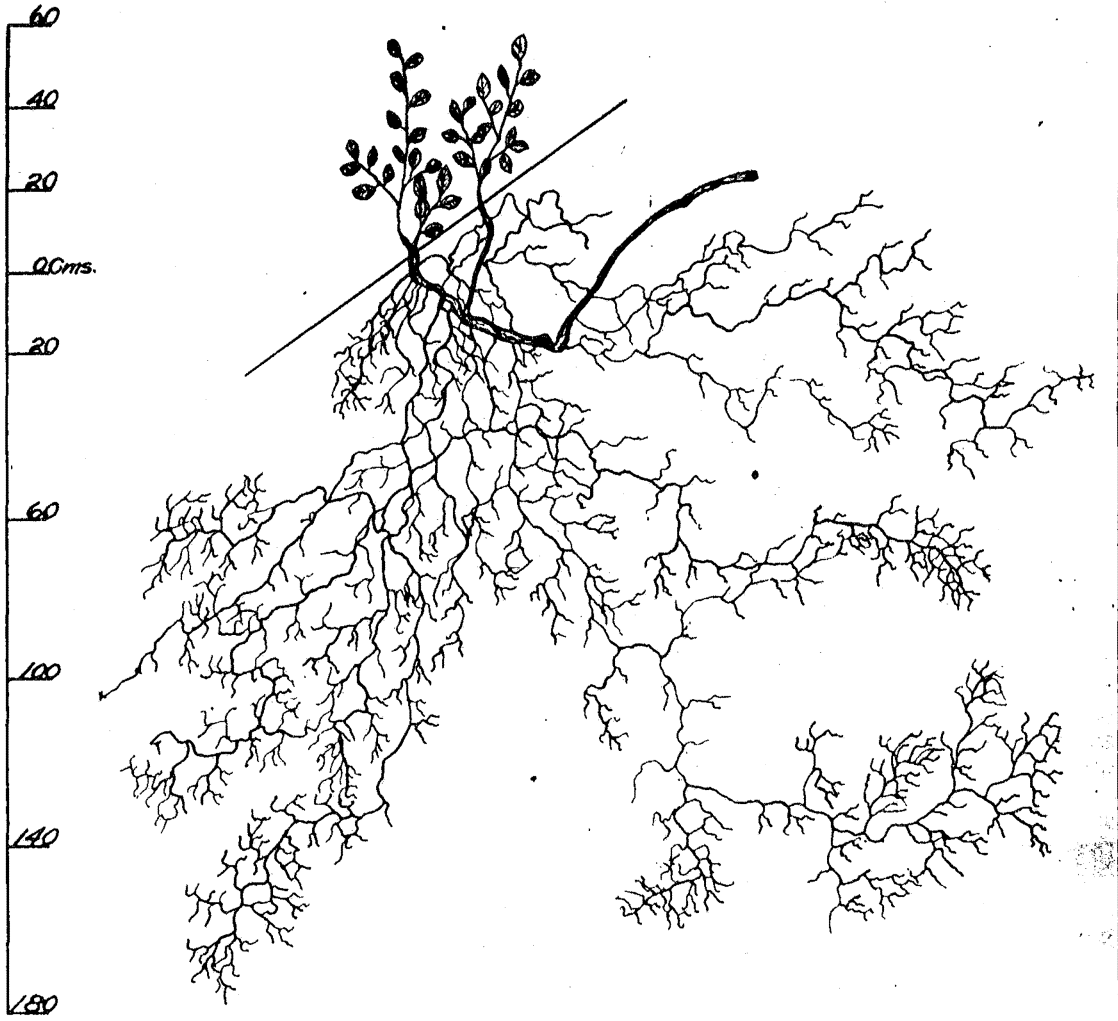
Shallow as well as deep-rooted species occur within the semitap root class. For example, the roots of Phlox longifolia and Potentilla blaschkeana penetrate only to a depth of 50 to 75 cms, which is no greater than the depth penetrated by annual forbs, while Eriogonum heracleoides, Lupinus spp., Balsamorhiza sagittata, and Lithospermum

* Not drawn

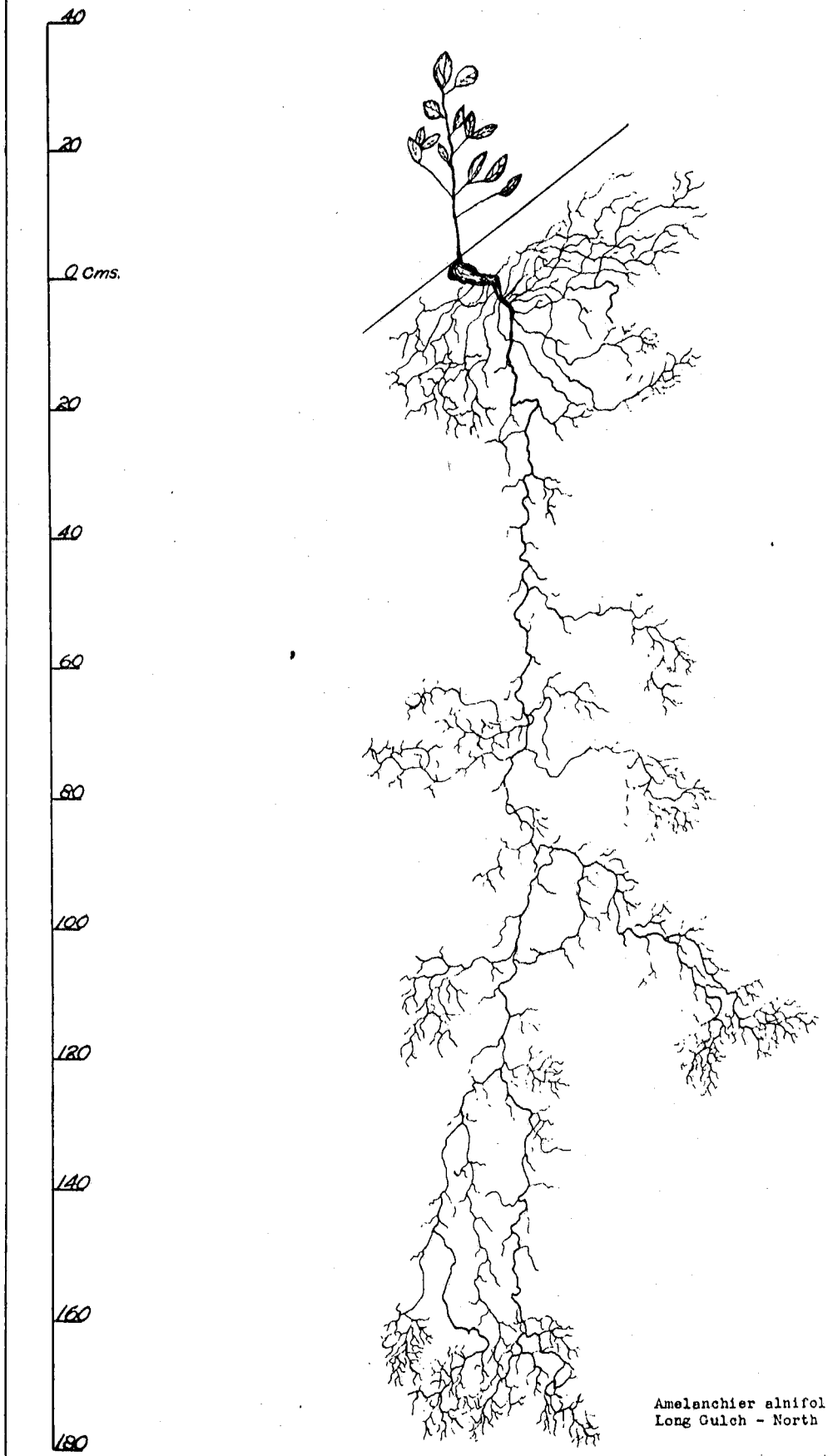
ruderale were found to penetrate to depths of 235, 240, 270, and 300 cms, respectively. Intermediate between these two extremes are such plants as Clematis hirsutissima, Lappula floribunda, and Astragalus purshii which develop roots 100 to 140 cms in length.



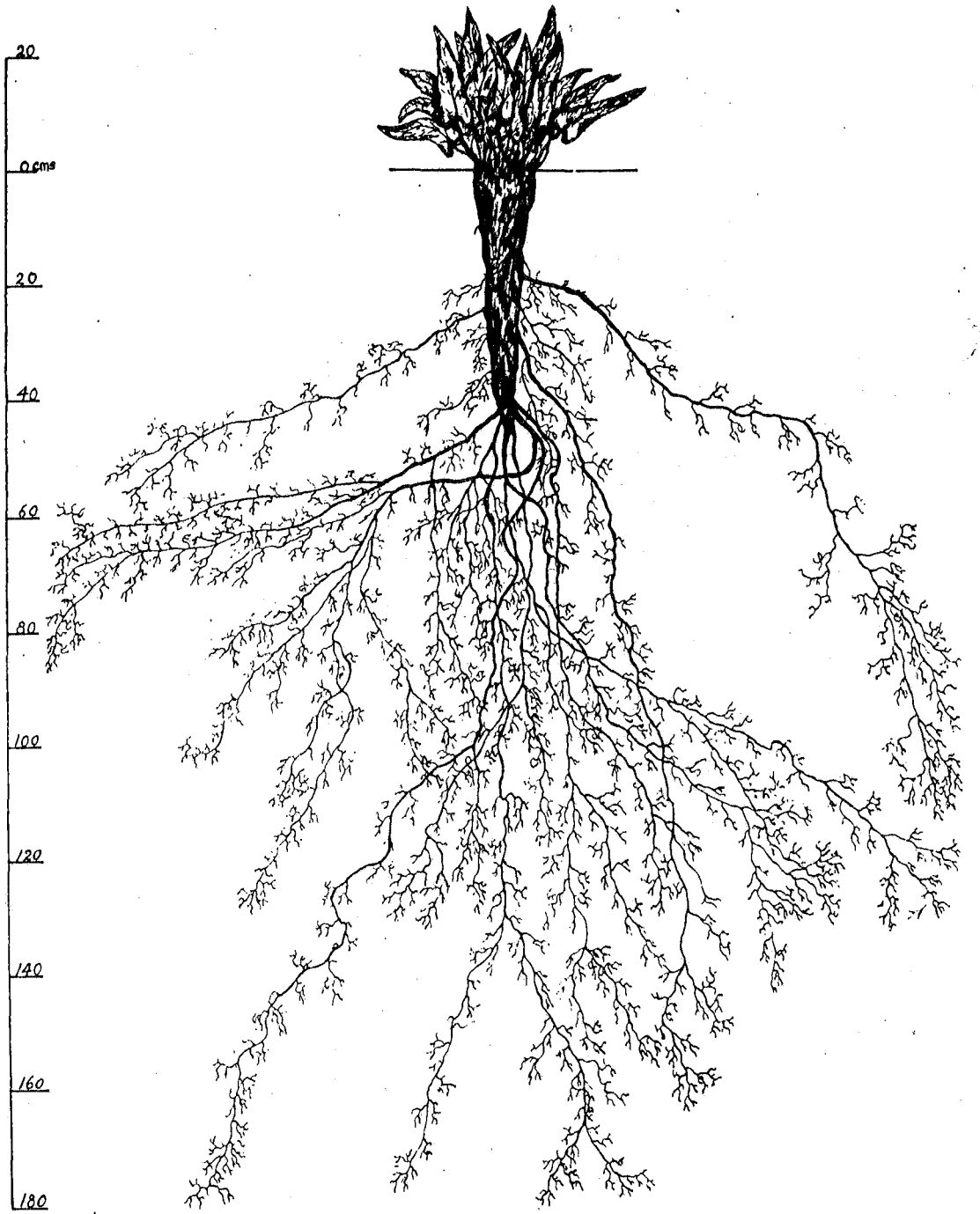
Astragalus purshii, Dougl.
Lone Gulch



Amelanchier alnifolia, Nutt.
Long Gulch - North slope

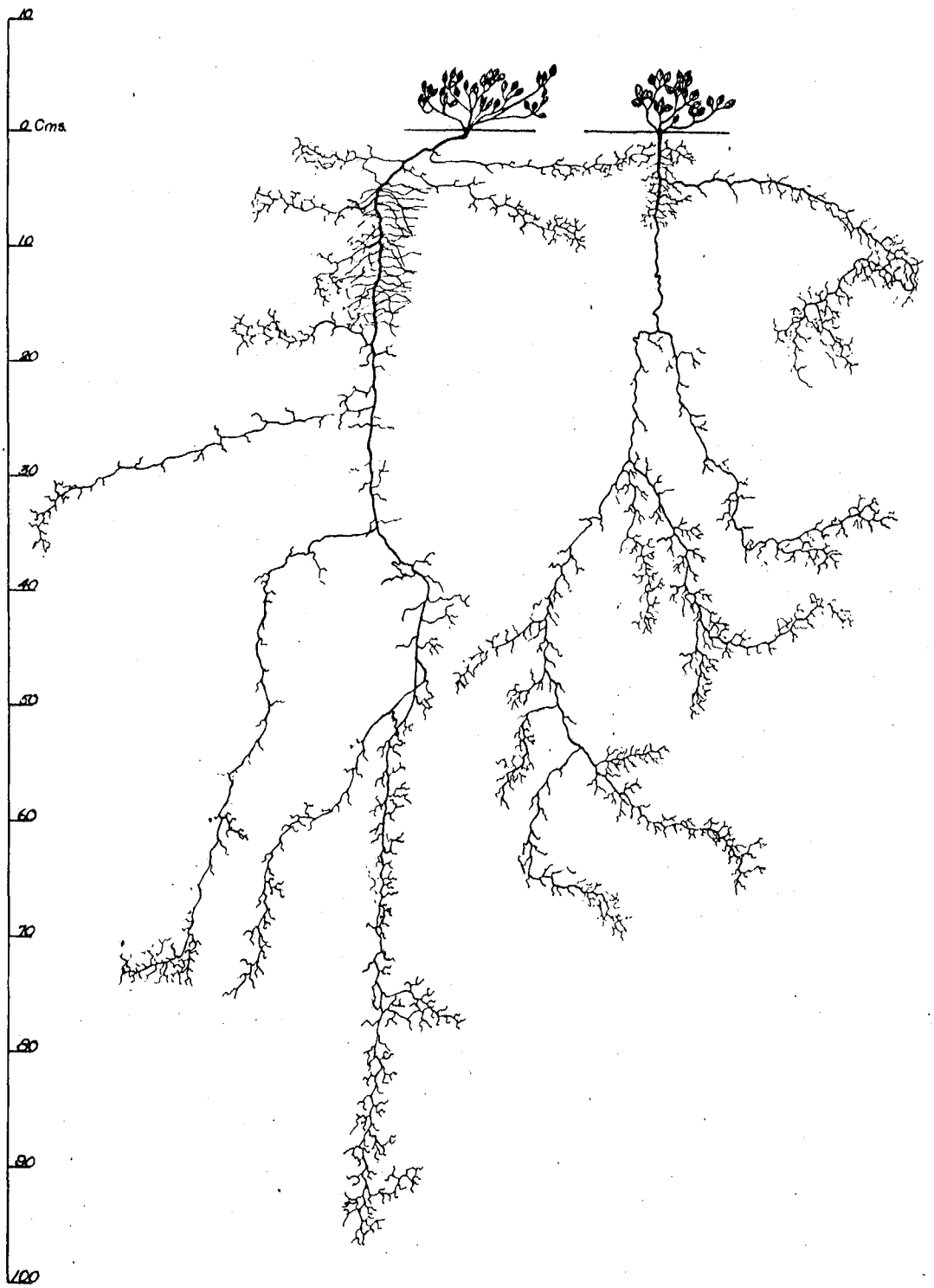


Amelanchier alnifolia, Nutt.
Long Gulch - North slope

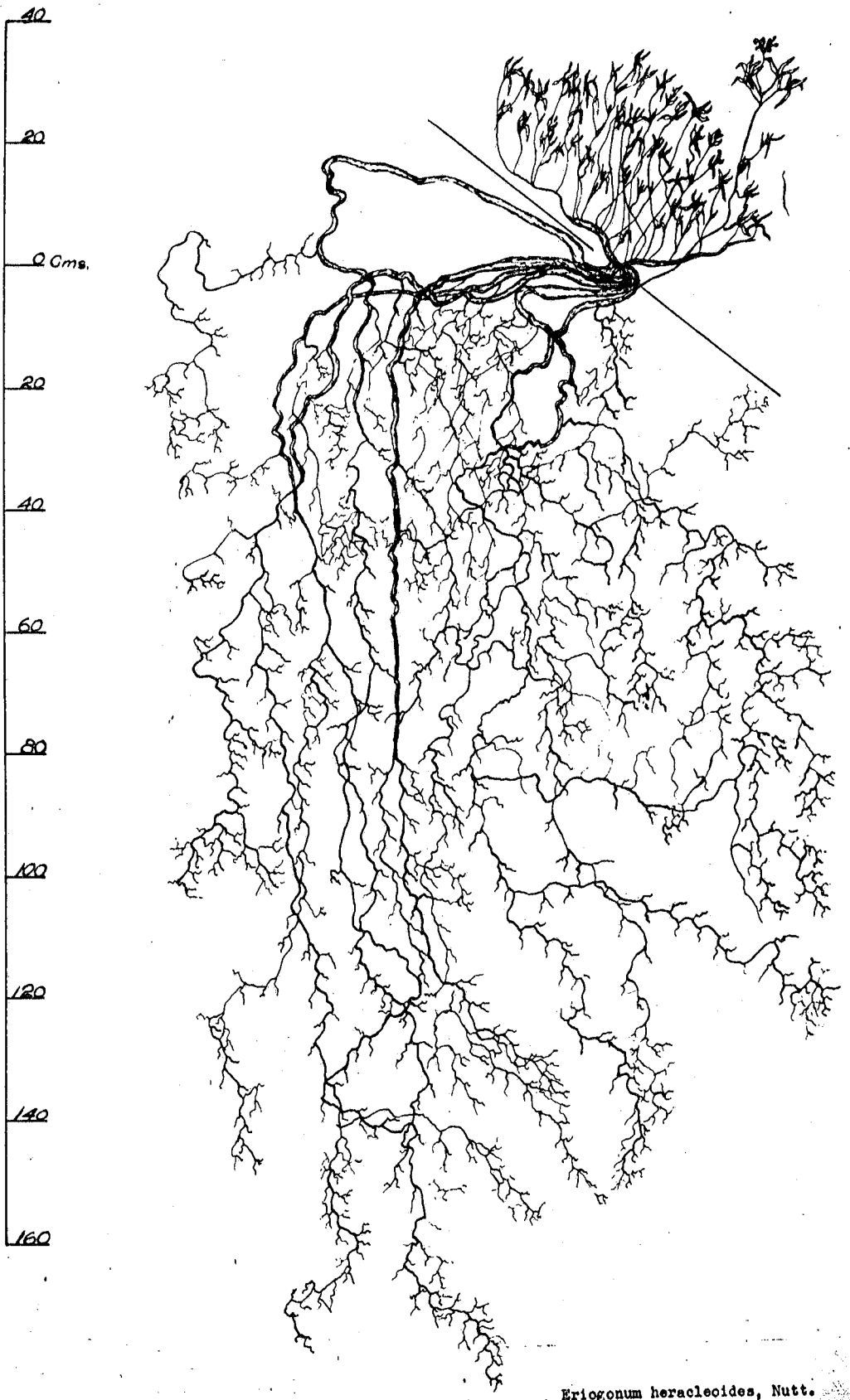


Balsamorhiza sagittata, (Pursh.) Nutt.
Long Gulch - South slope

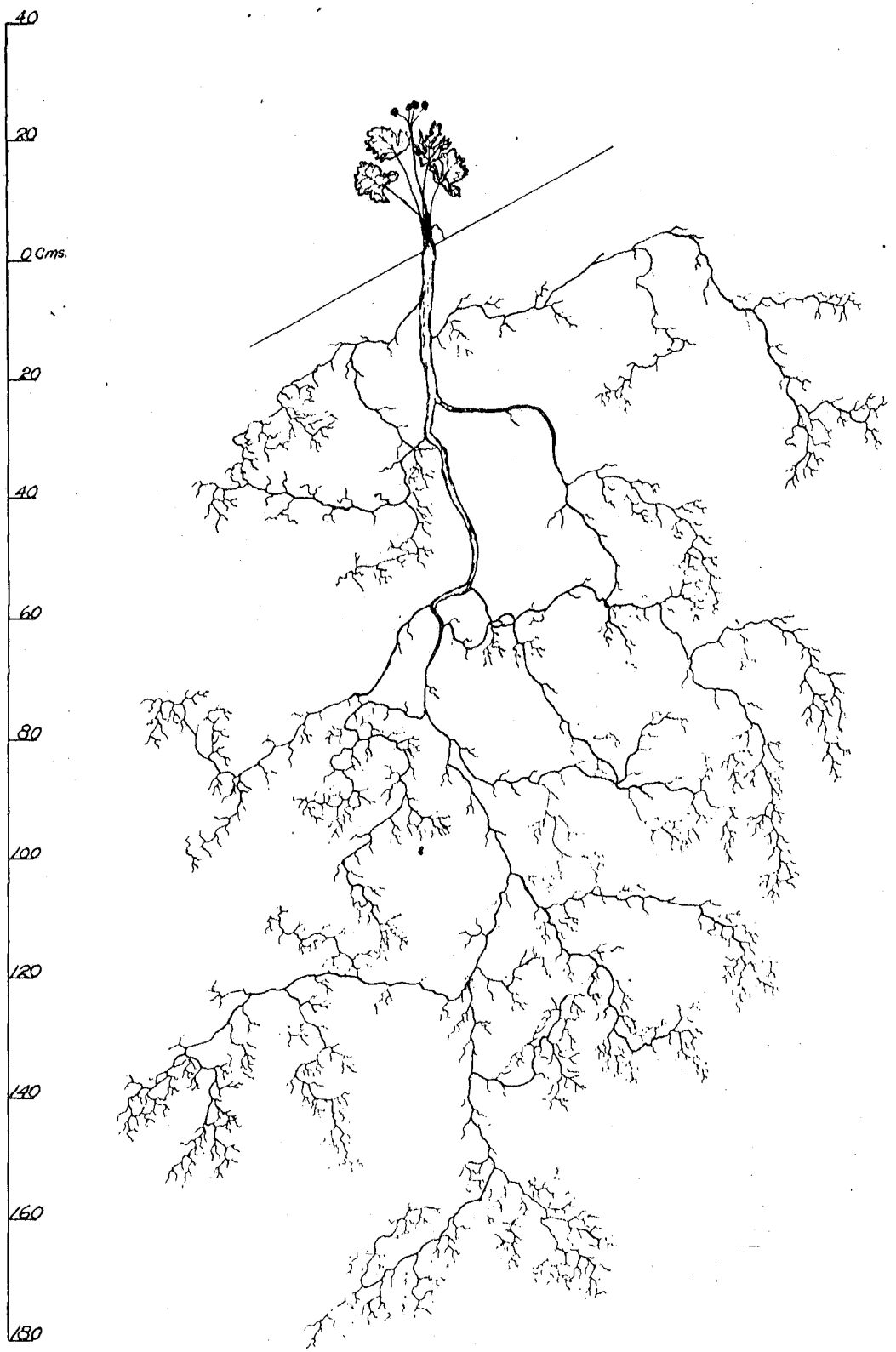
Clematis hirsutissima, Pursh.
Long Gulch - North slope.



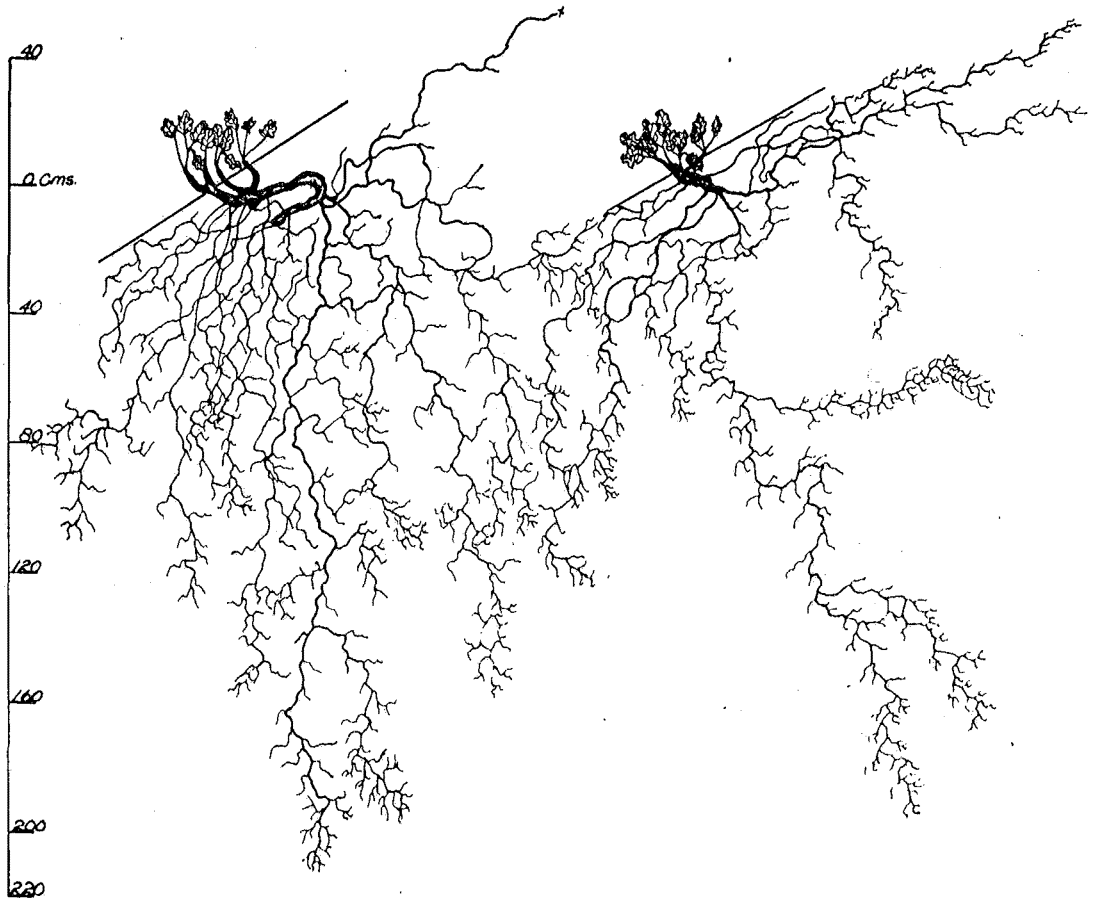
Eriogonum umbellatum, Torr. Ann.
Long Gulch - South slope



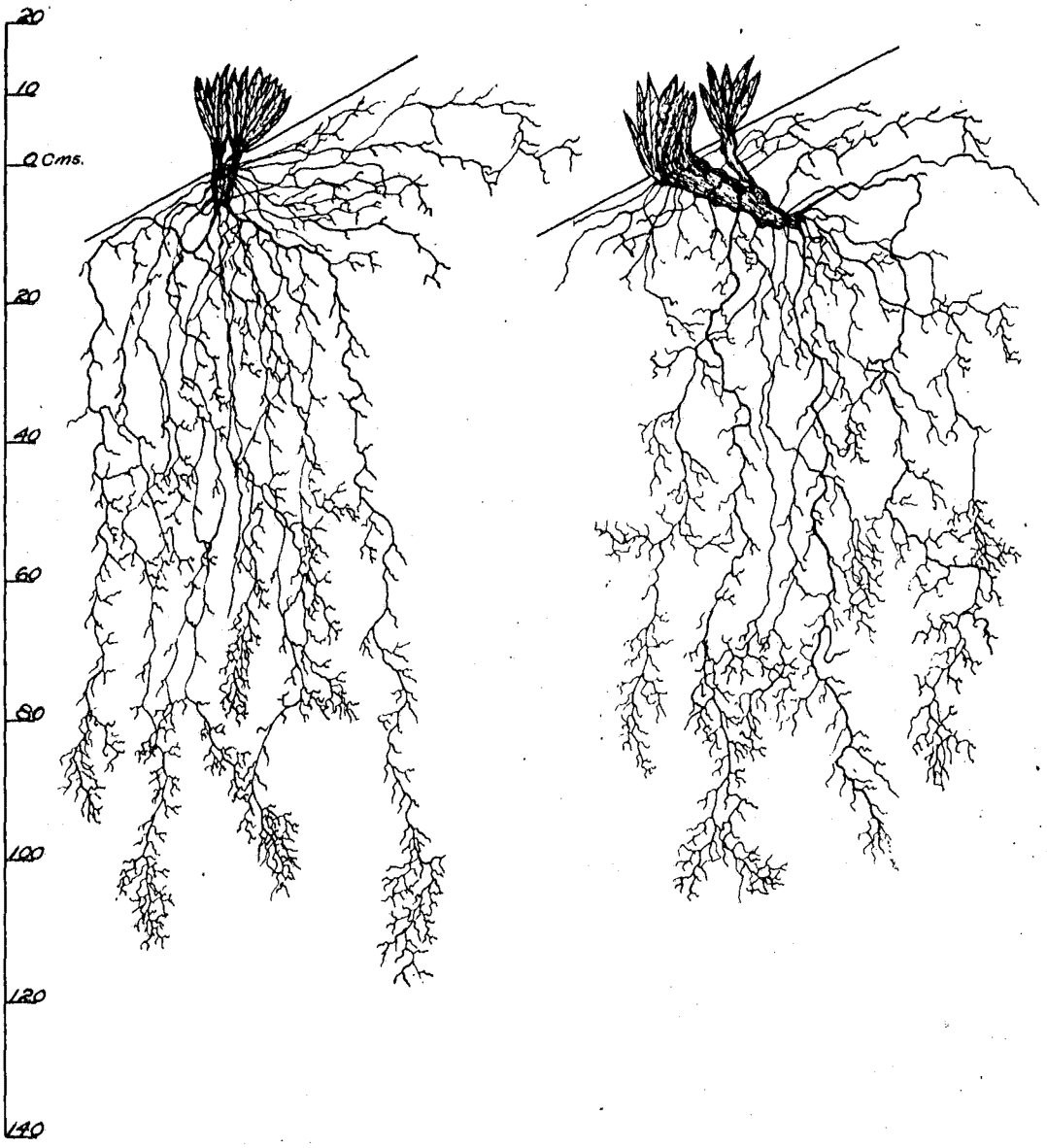
Eriogonum heracleoides, Nutt.
Long Gulch - North slope



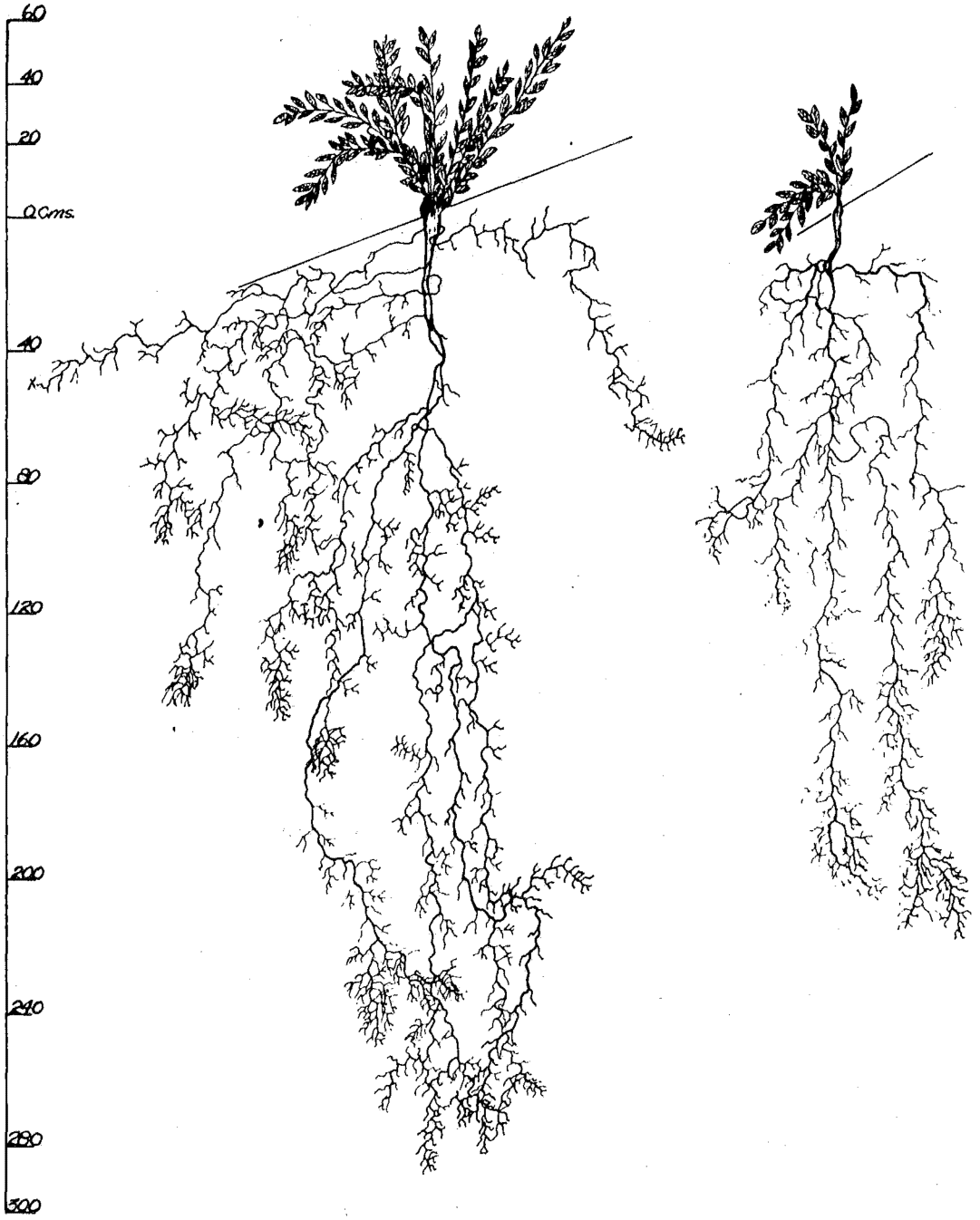
Geranium viscosissimum, Fisch & Mey.
Long Gulch - North slope



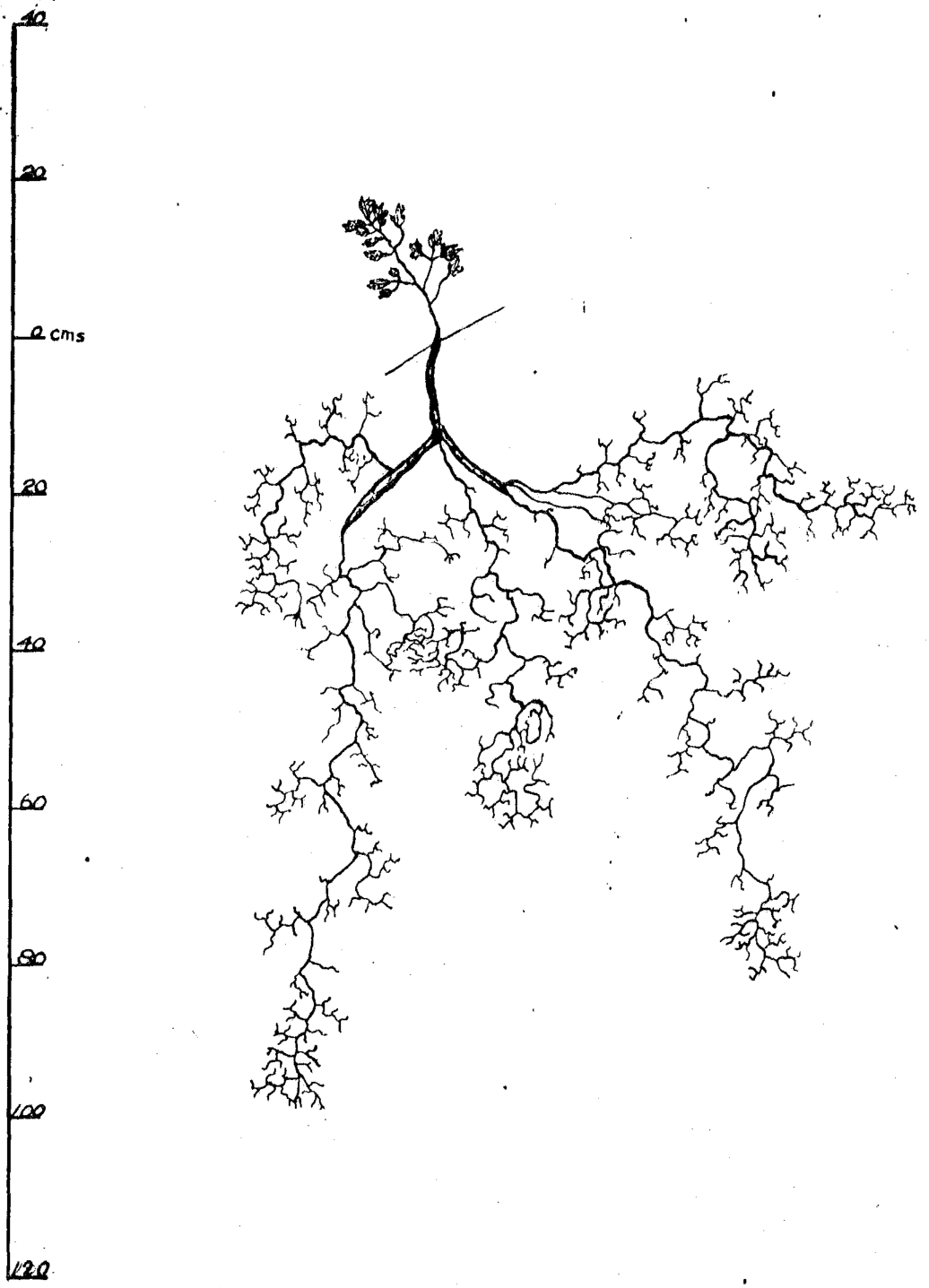
Heuchera sp.
Long Gulch - North slope



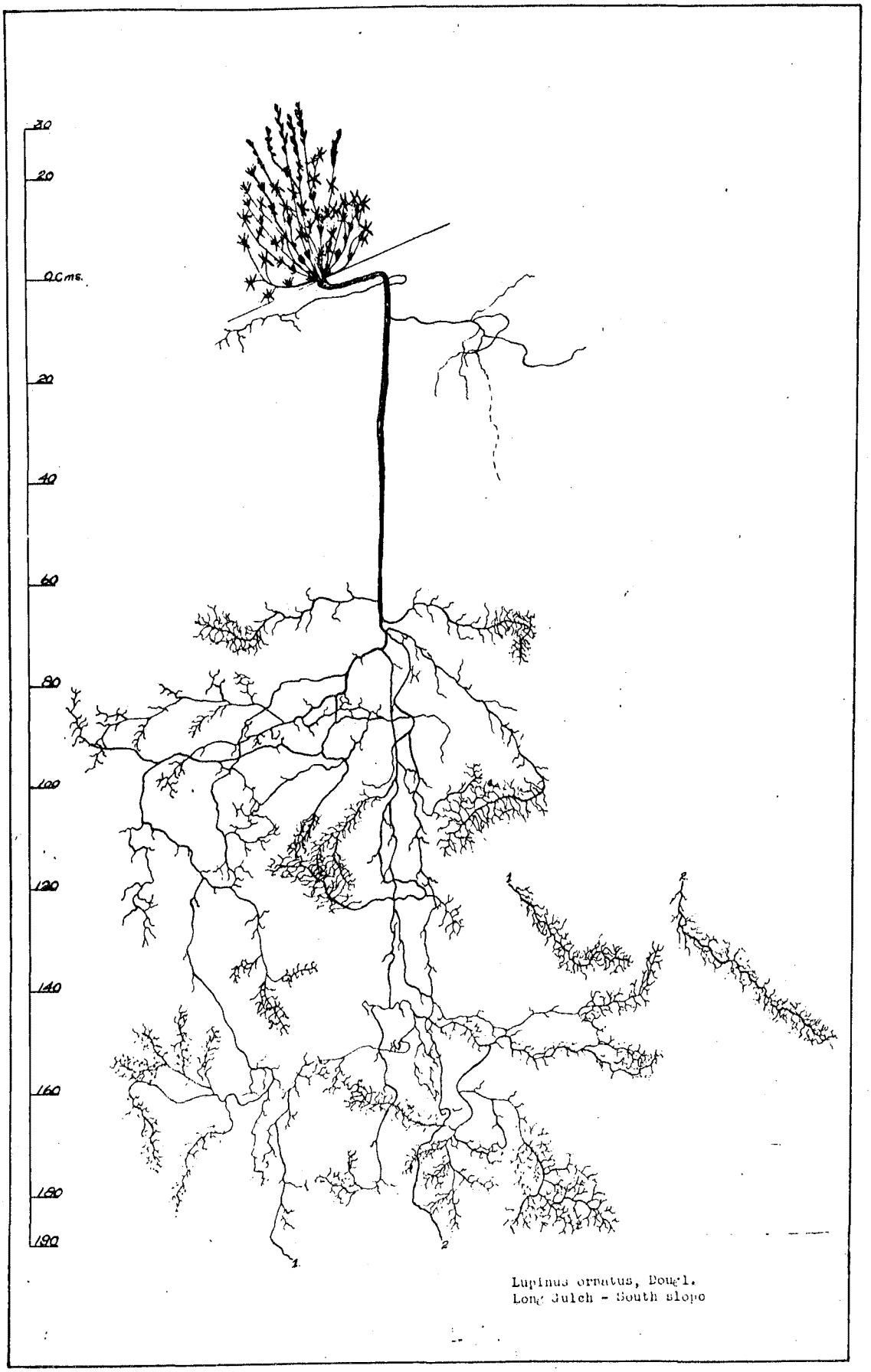
Lappula floribunda (Lehm) Greene
Long Gulch - North slope



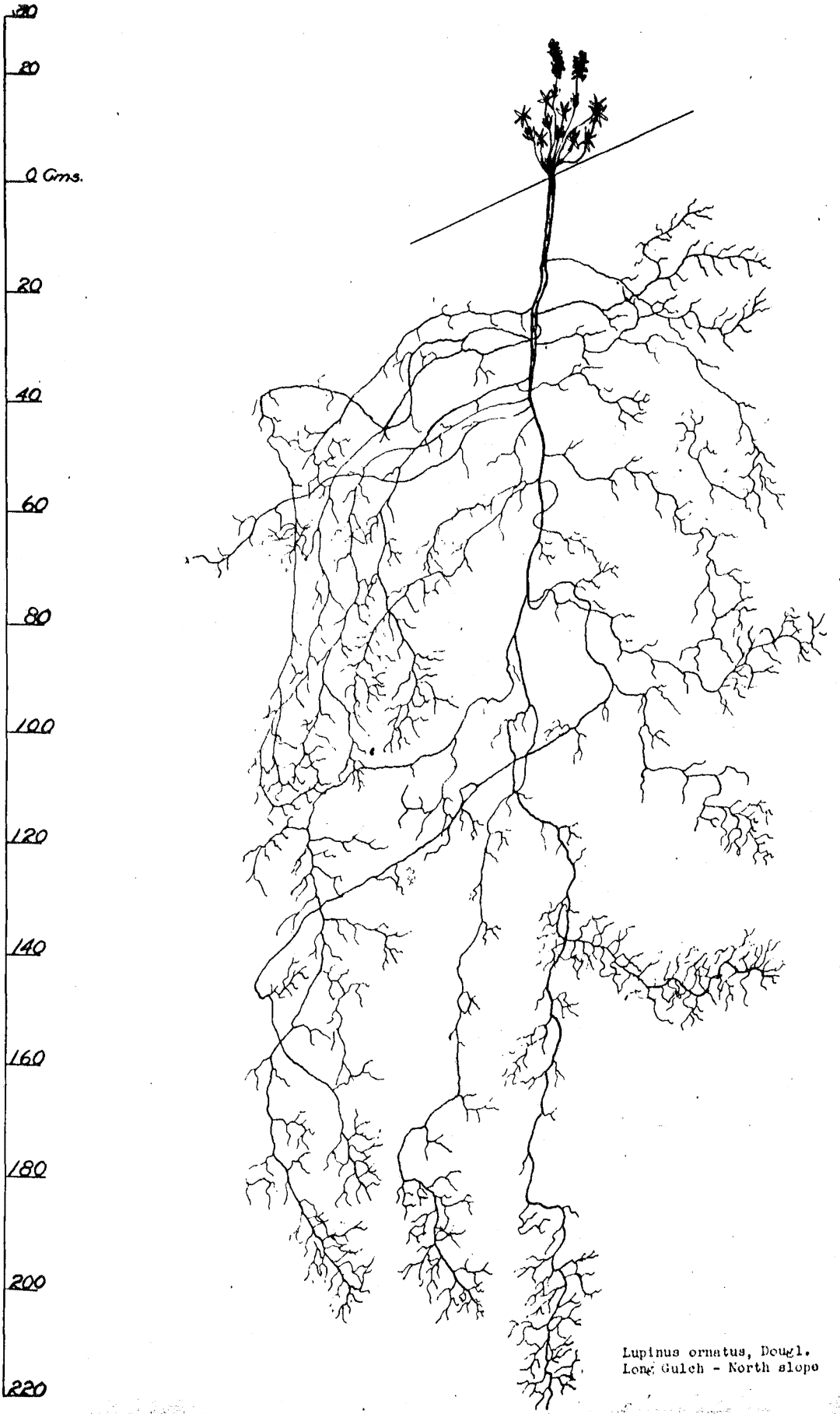
Lithospermum ruderale, Dougl.
Long Gulch - North slope



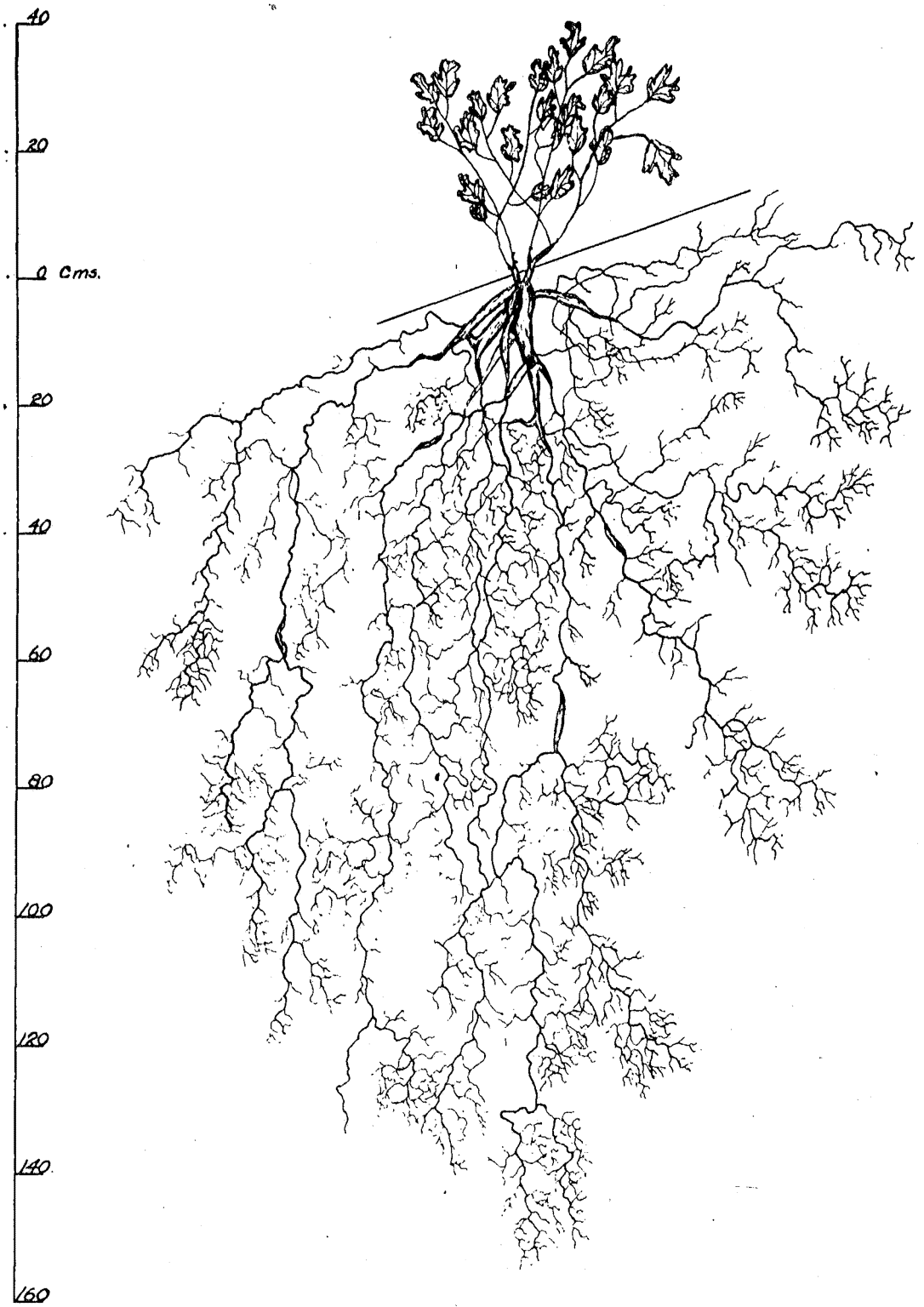
Pinonii brownii, Dougl.
Long Gulch - North slope



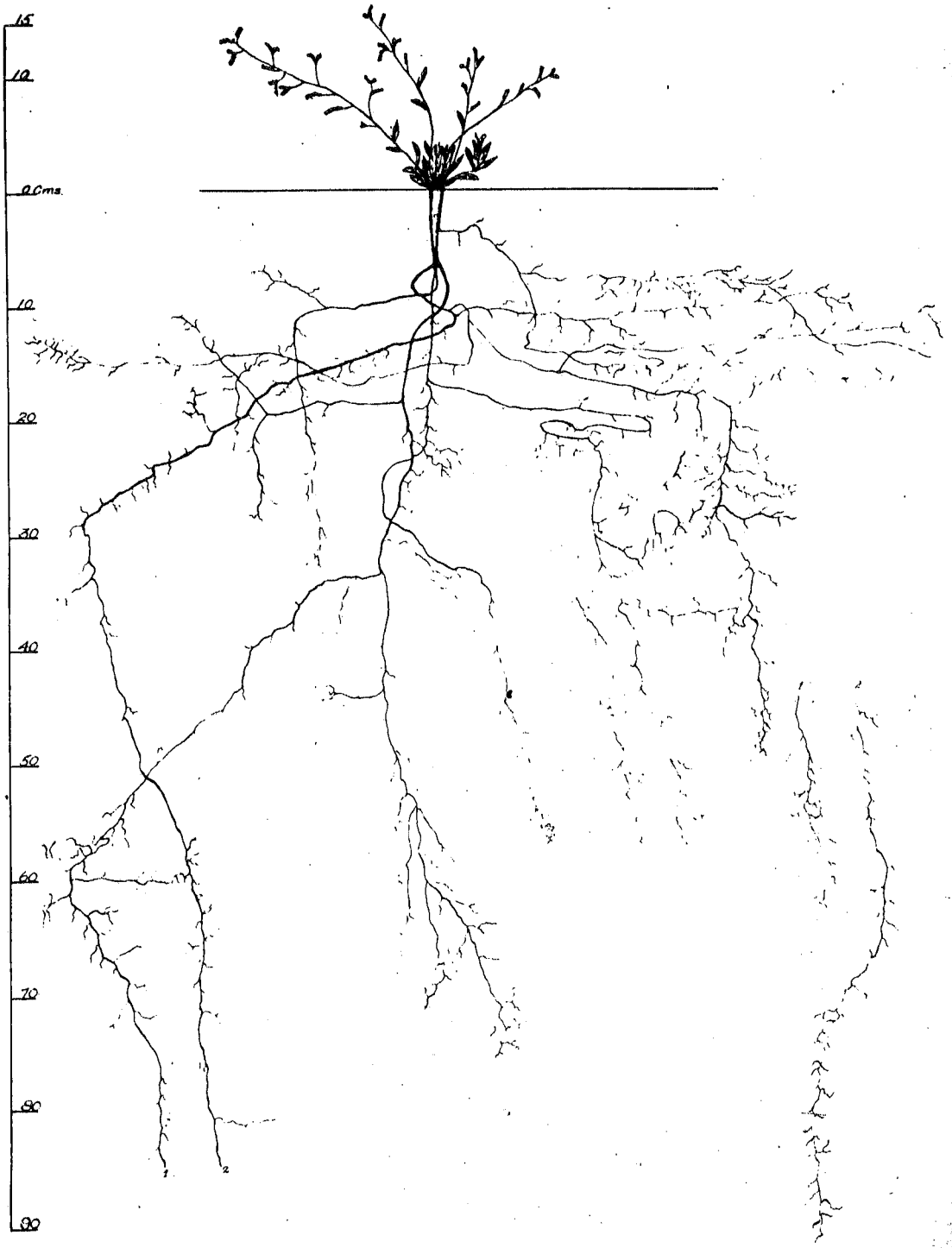
Lupinus ornatus, Dougl.
Long Gulch - South slope



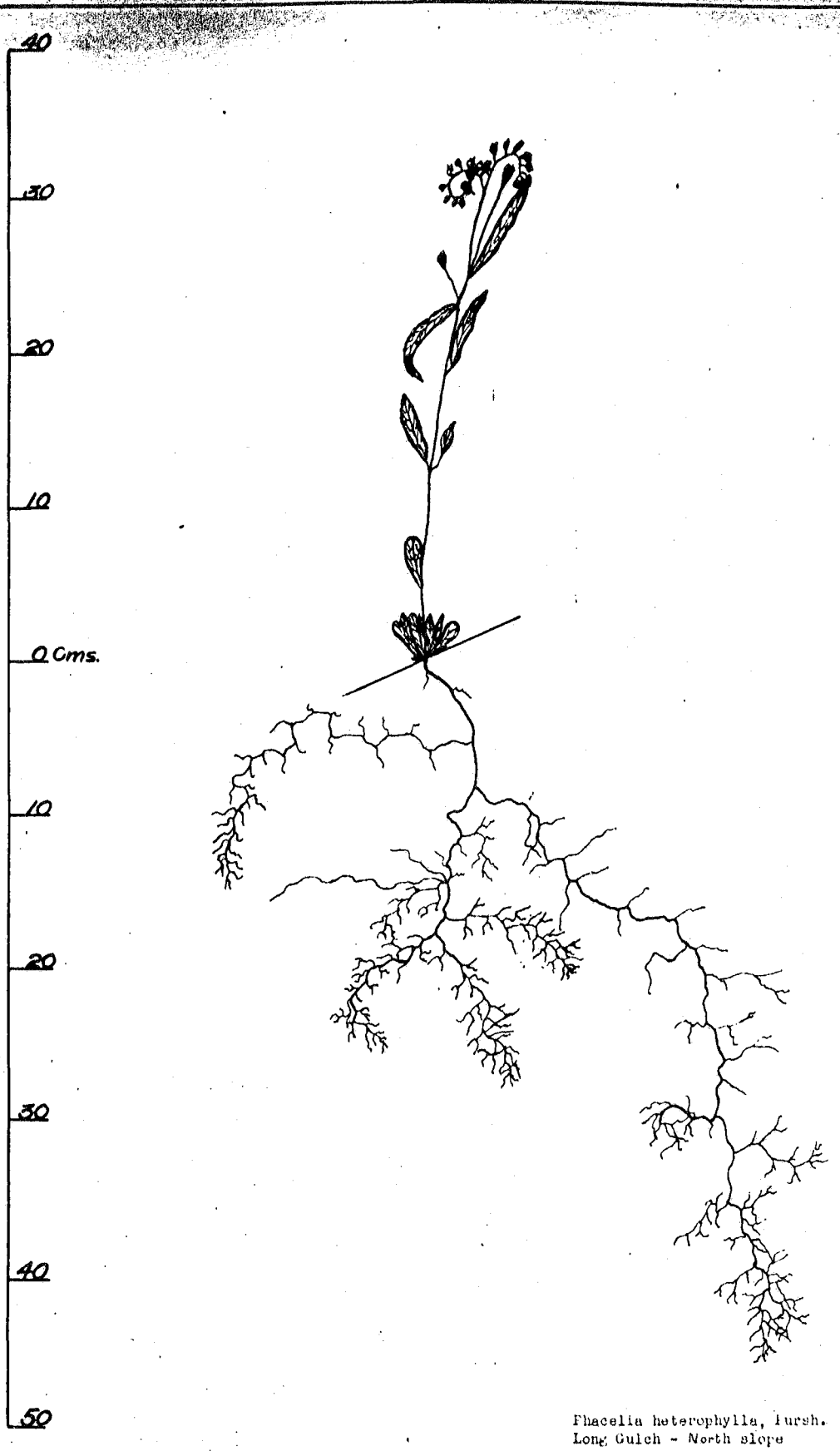
Lupinus ornatus, Dougl.
Long Gulch - North slope



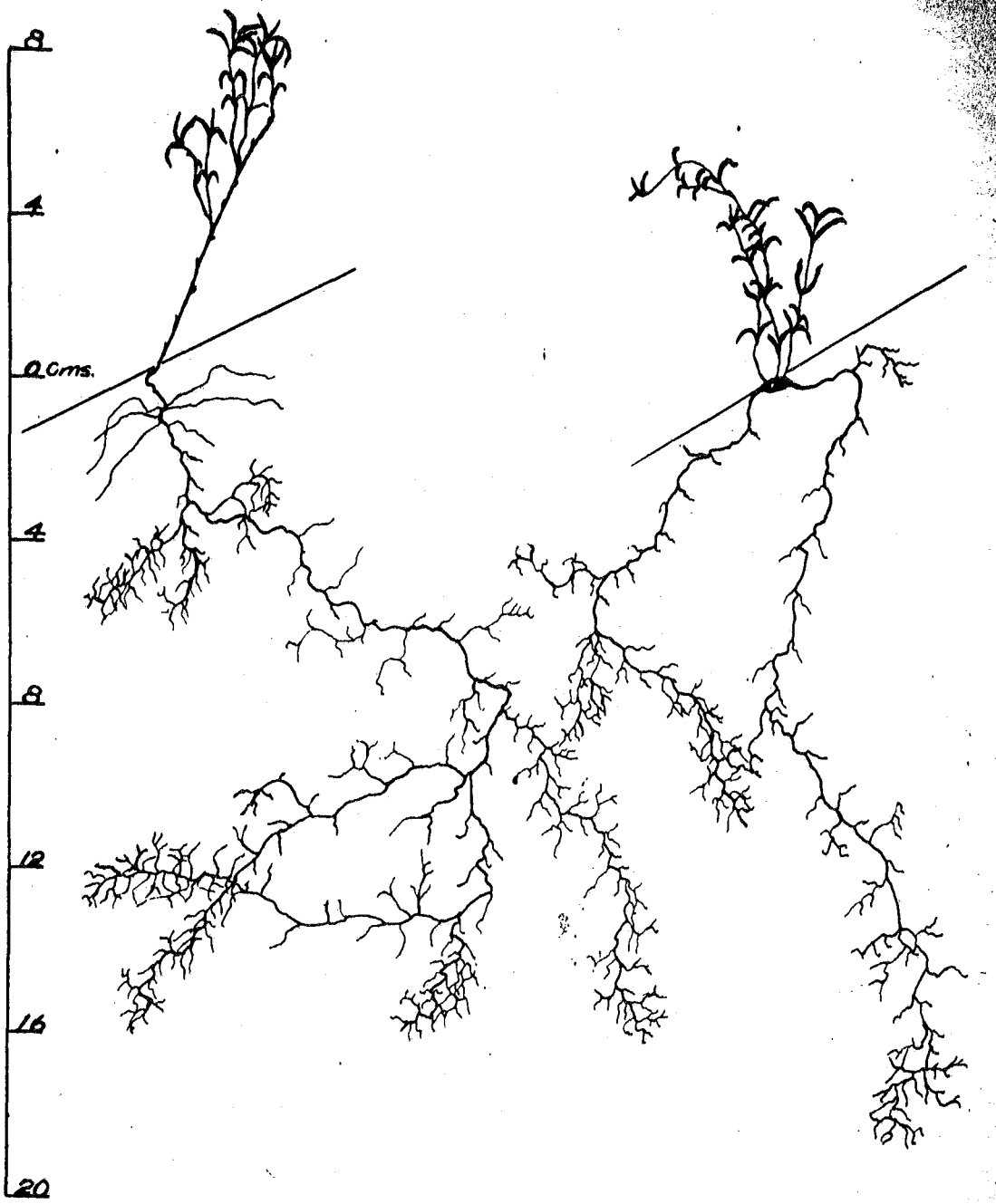
Paeonii brownii, Dougl.
Long Gulch - North slope



Phacelia heterophylla, Pursh.
Long Gulch - South slope



Phacelia heterophylla, Pursh.
Long Gulch - North slope



Phlox longifolia, Nutt.
Long Gulch - North slope

Class Four - Species with taproot systems

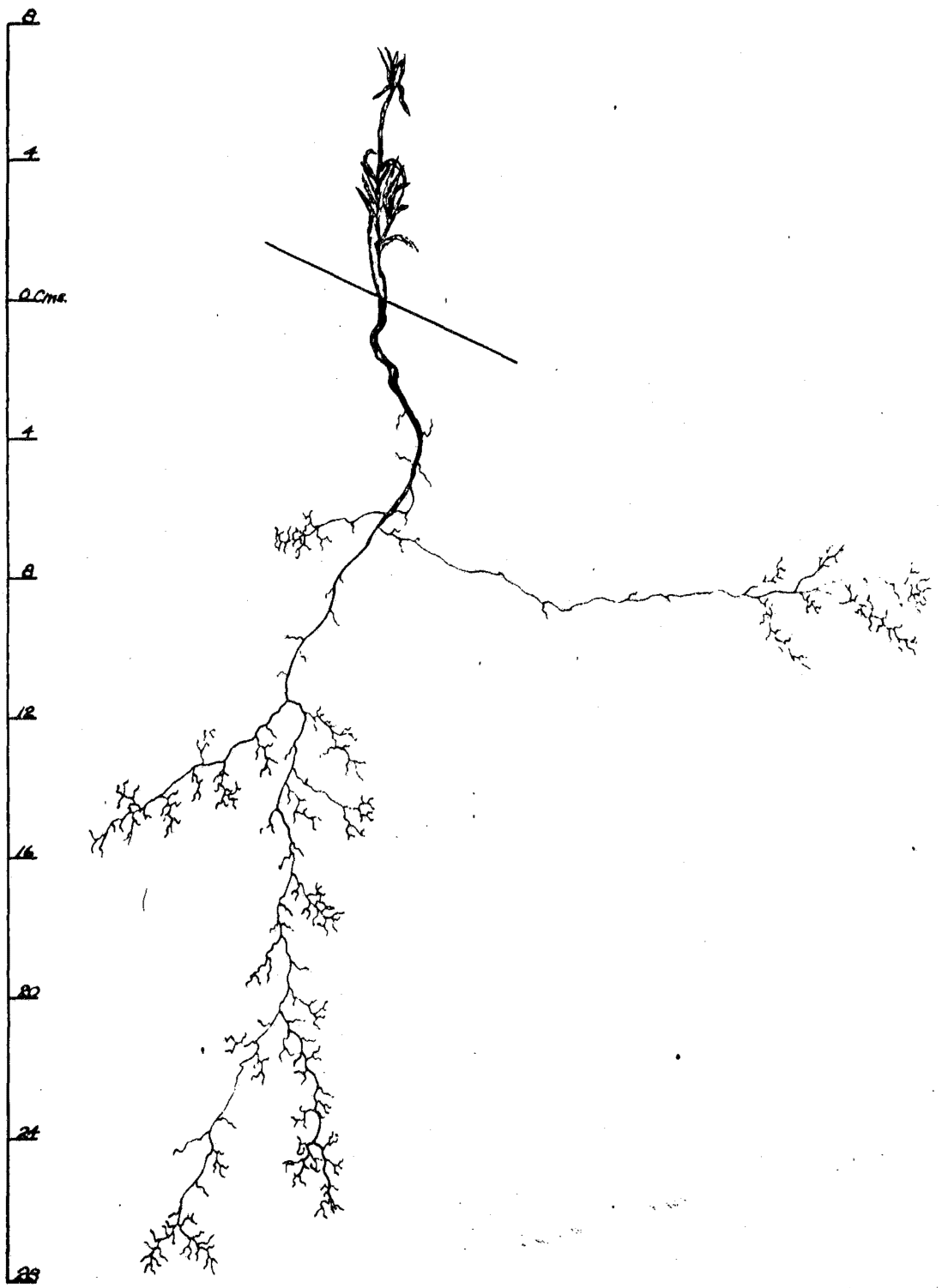
This class includes species having a single or forked taproot along which numerous short lateral roots are spaced. The fourteen species falling in this category are as follows:

Annuals & Biennials	Perennials
Agoseris heterophylla*	Aplopappus lanugenosus
Amsinckia rugosa*	Artemisia tridentata*
Arabis perelegans	Chrysothamnus spp.*
Collomia linearis	Crepis acuminata
Gayophytum diffusum	Viola purpurea*
Lactuca scarioloa integrata	Chaenactis douglasii
Silene spp.	
Spraguea nuda	

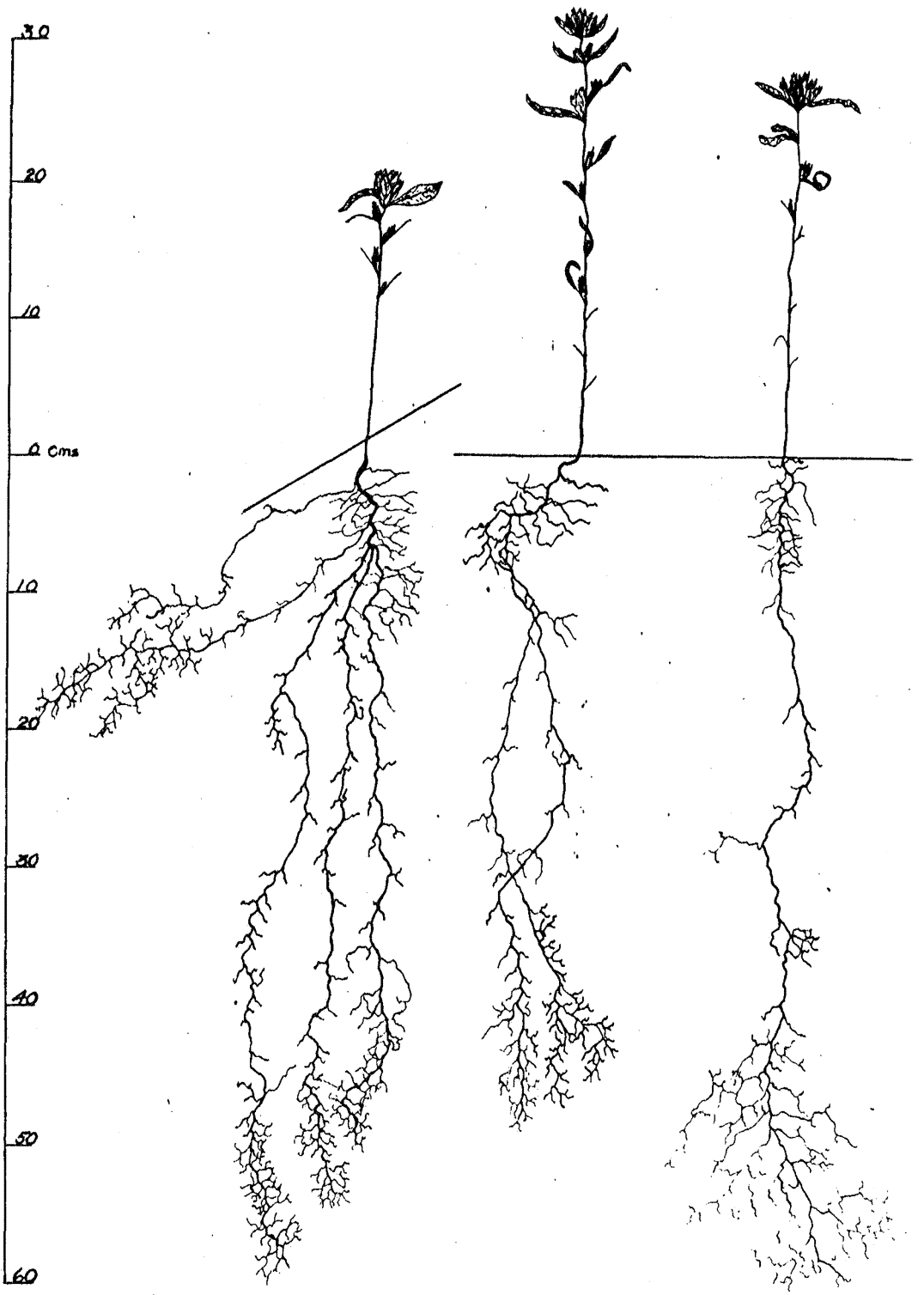
The annual and biennial forbs listed develop a taproot 15 to 60 cms in length with many small laterals, usually less than 5 cms long. These laterals are spaced along the entire length of the taproot.

Within the perennial group the browse species Artemisia tridentata and Chrysothamnus spp. develop a principal taproot commonly penetrating the soil to a depth of more than 200 cms. Laterals originating from the taproot of the browse species are longer, fewer in number, and more irregularly distributed along the taproot than are the laterals of the annual and biennial forbs. The perennial forbs develop a root system on a smaller scale, but otherwise rather similar to the root systems of the browse species.

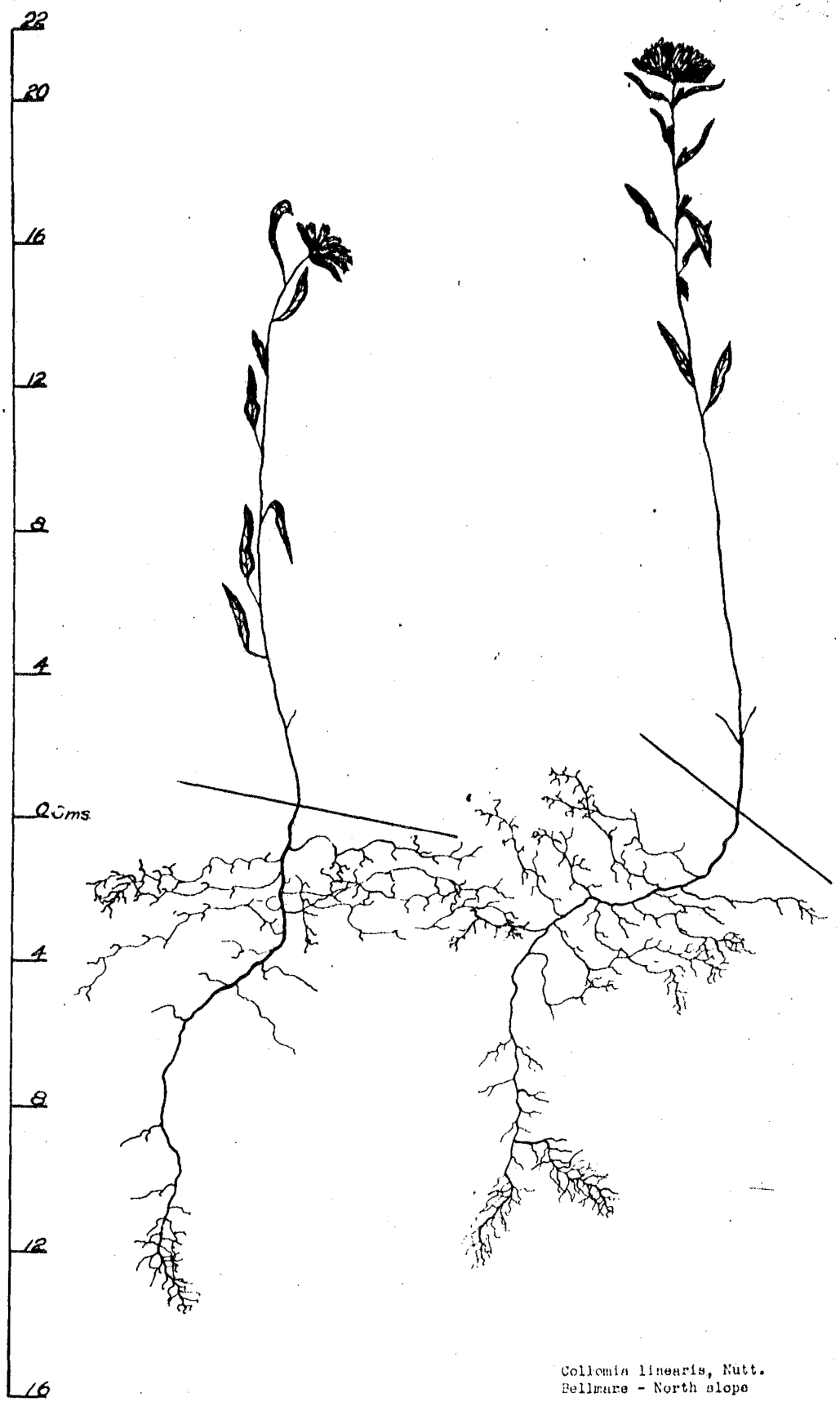
* Not drawn



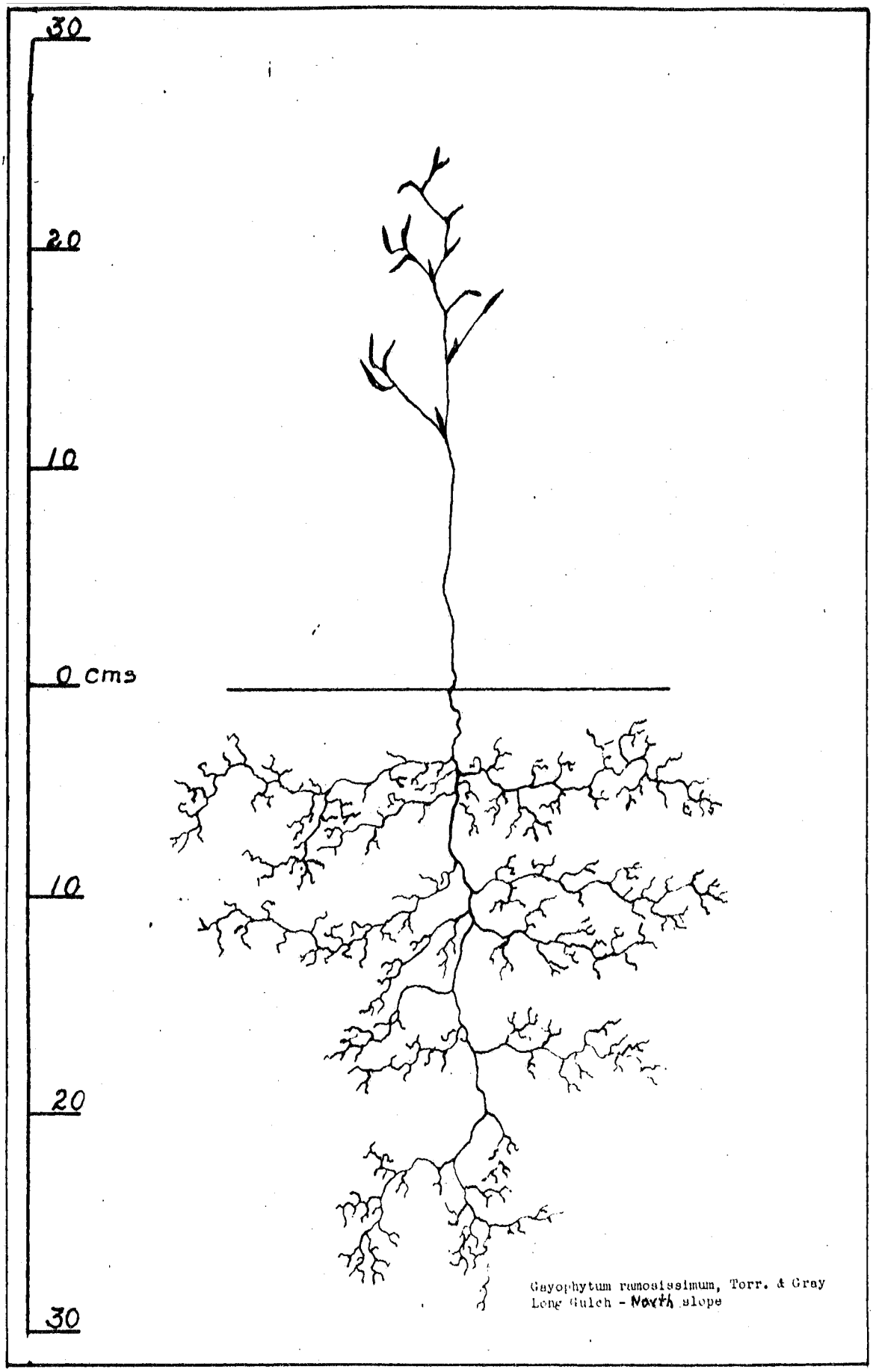
Arabis perelegans, A. Nels.
Long Gulch - North slope



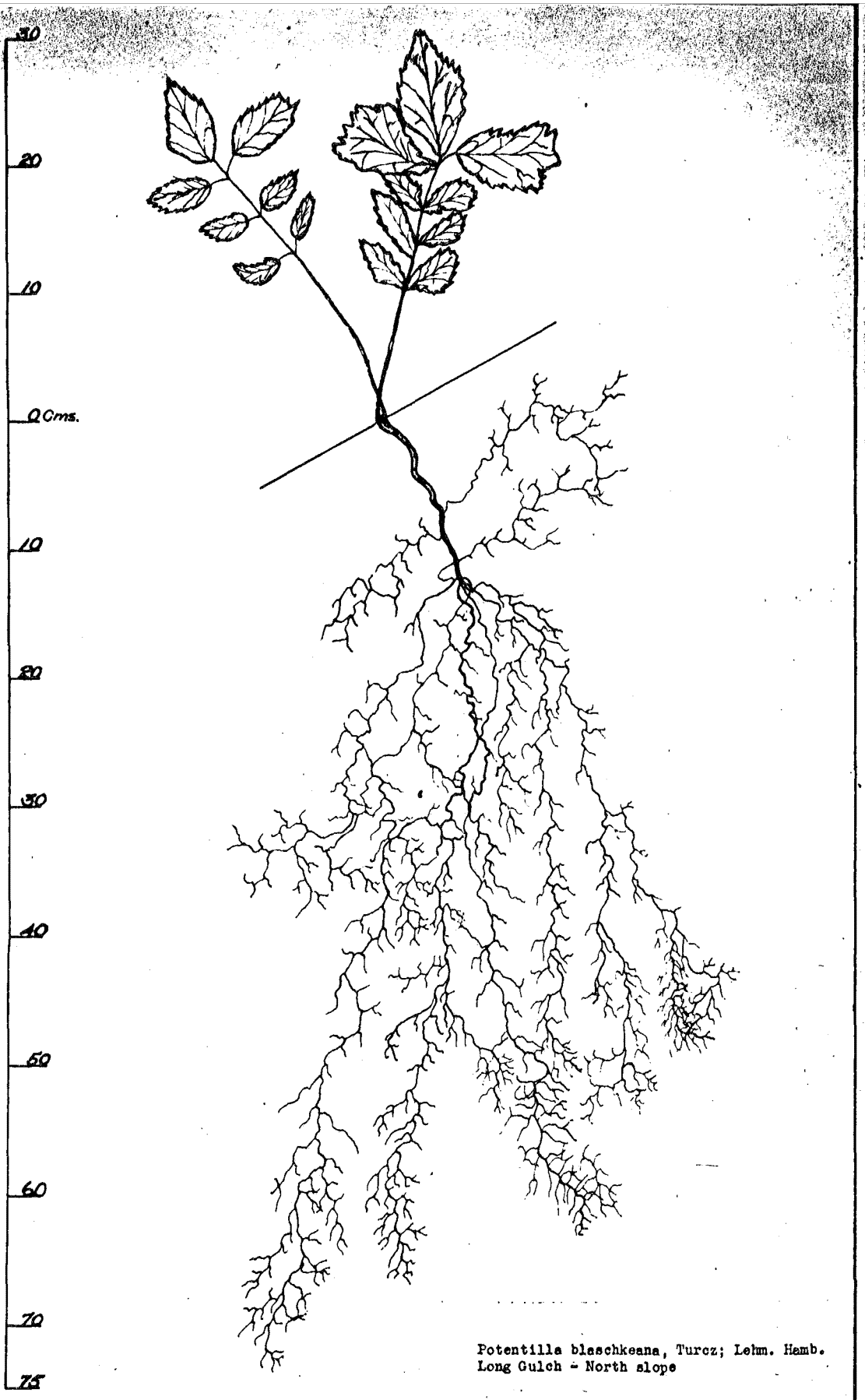
Collomia linearis, Nutt.
Long Gulch - North slope



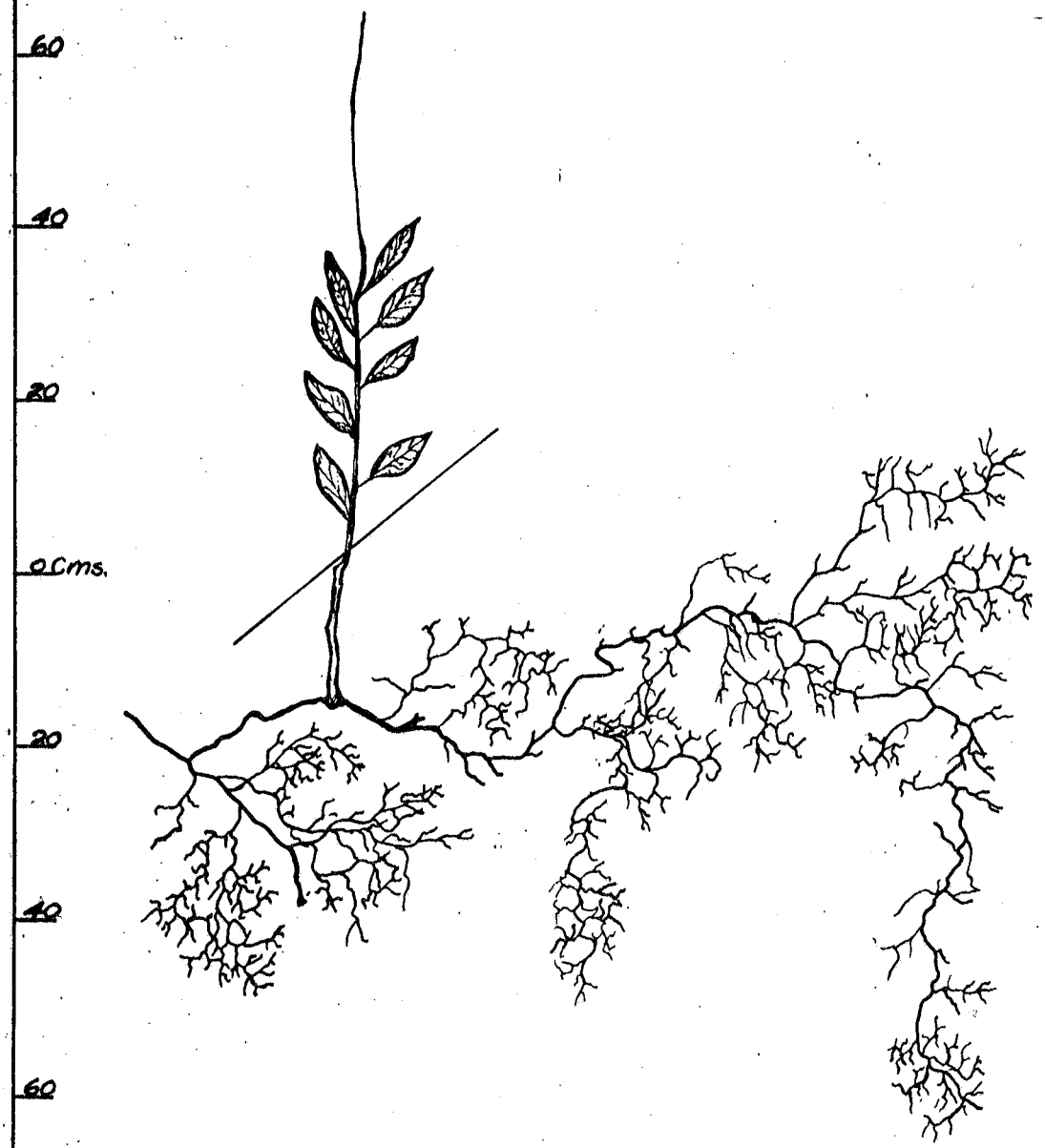
Collomia linearis, Nutt.
Bellmare - North slope



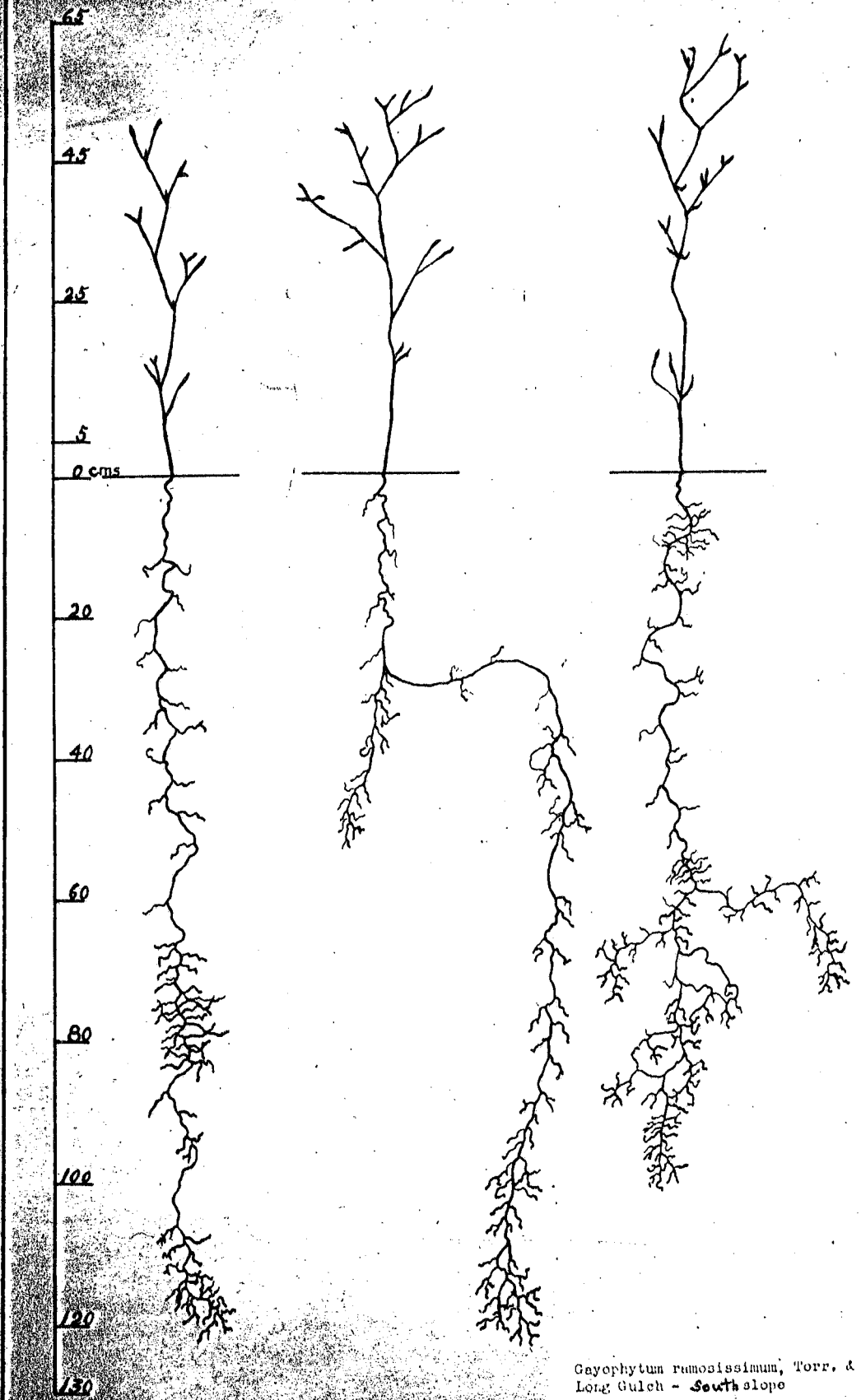
Gayophytum ramosissimum, Torr. & Gray
Long Gulch - North slope



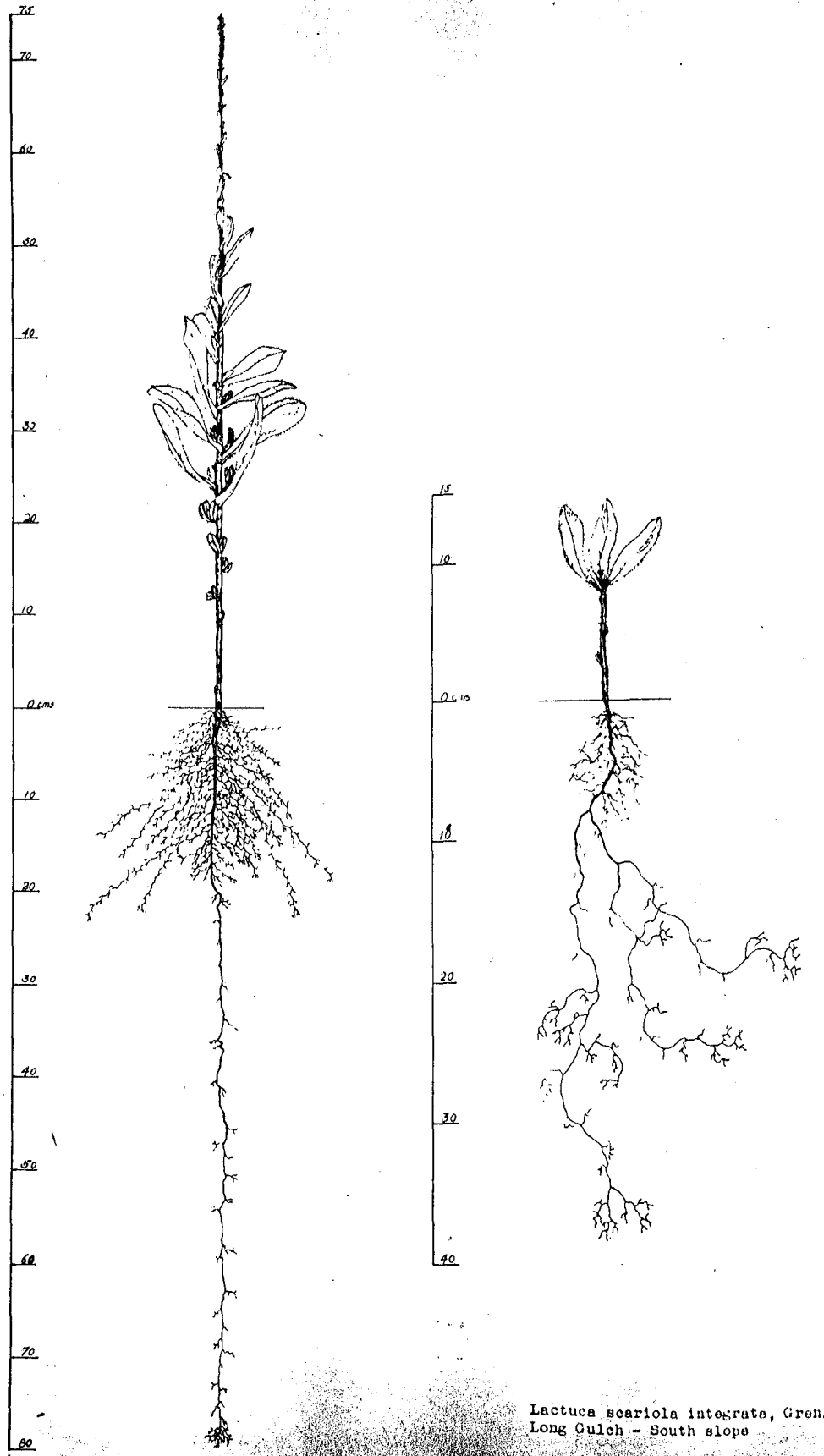
Potentilla blaschkeana, Turcz; Lehm. Hamb.
Long Gulch - North slope



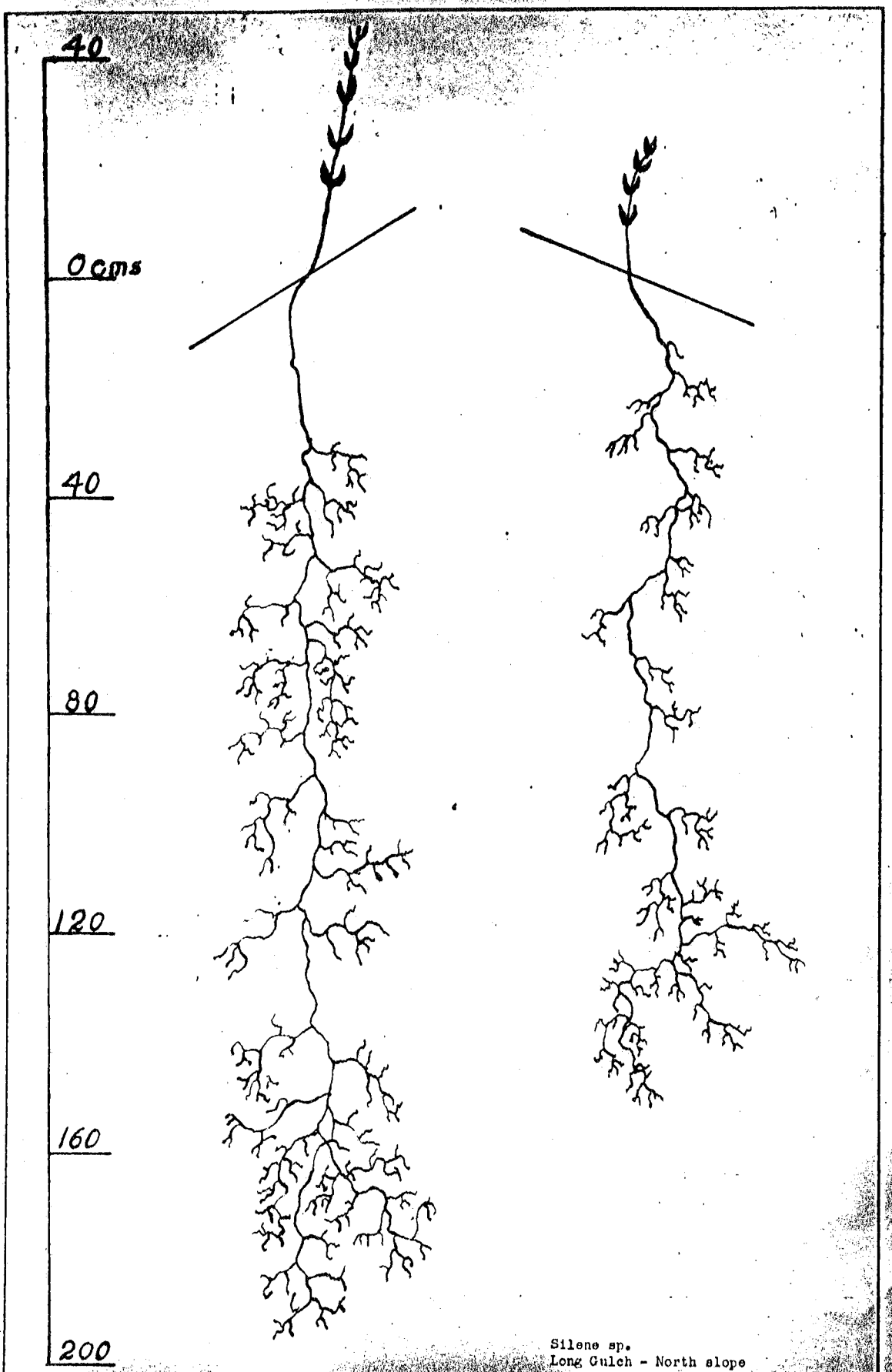
Prunus melanocarpa, A. Nels.
Long Gulch - North slope



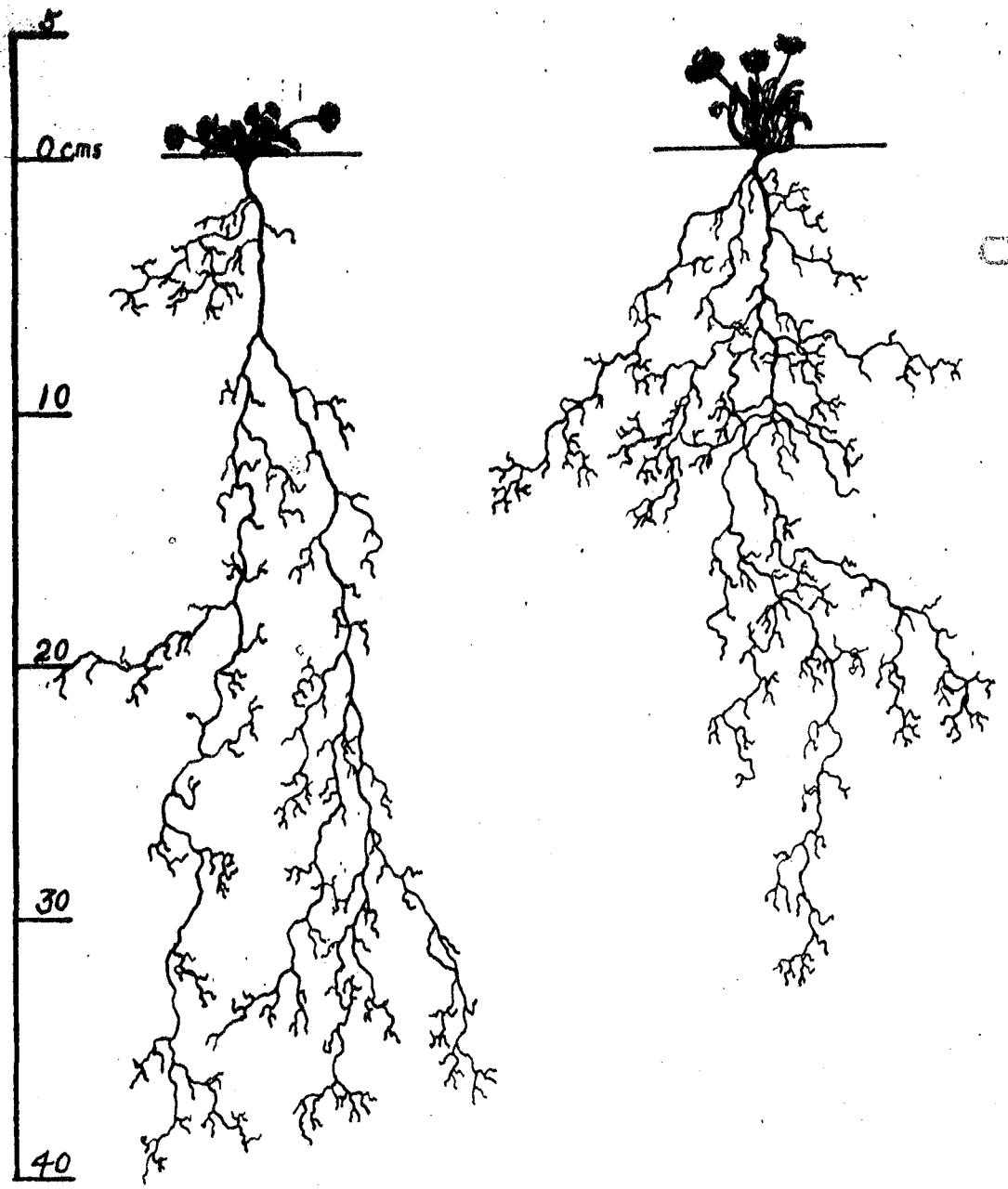
Gayophytum ramosissimum, Torr. & Gray
Long Gulch - South slope



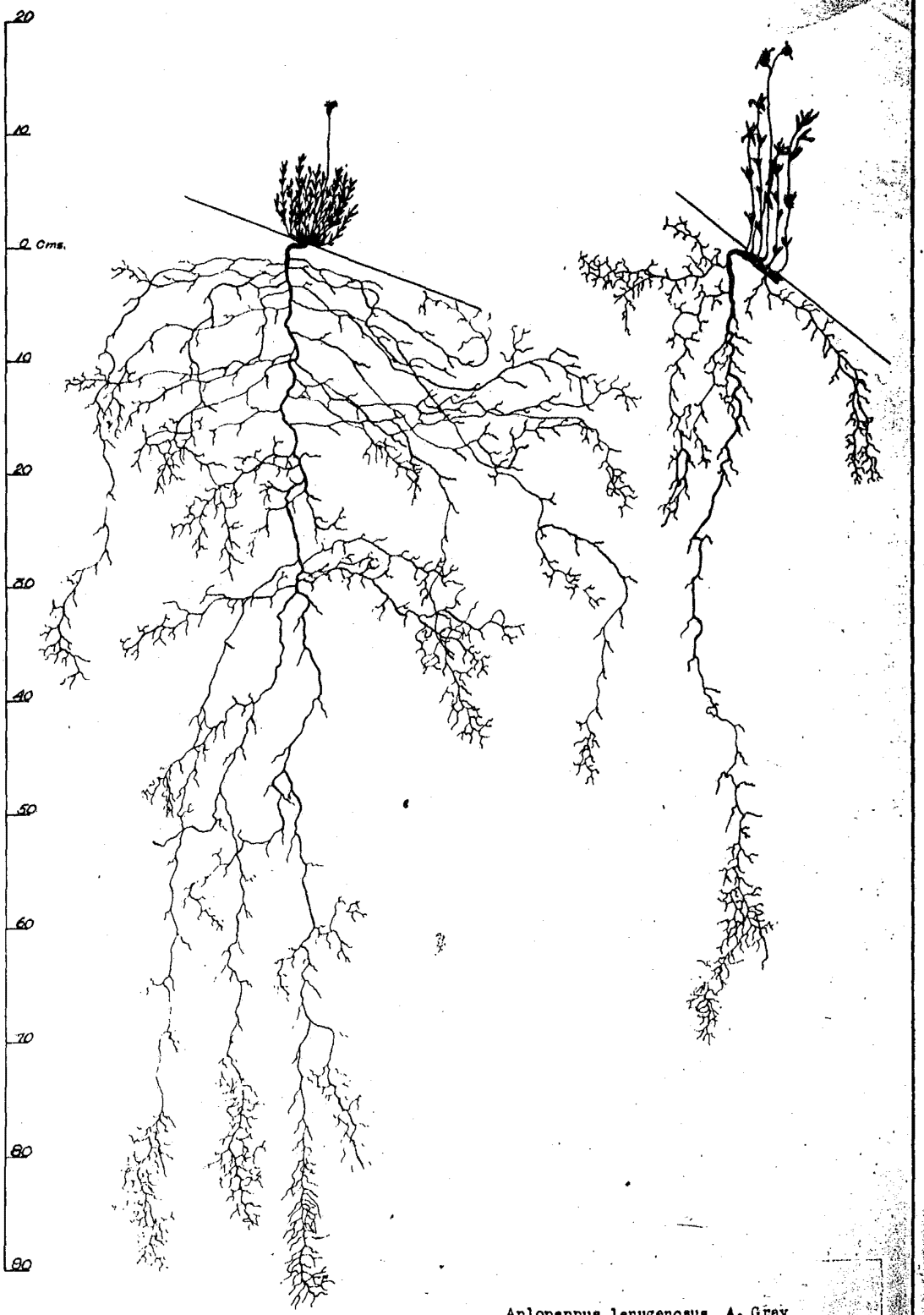
Lactuca scariola integrata, Gren.& Godr.
Long Gulch - South slope



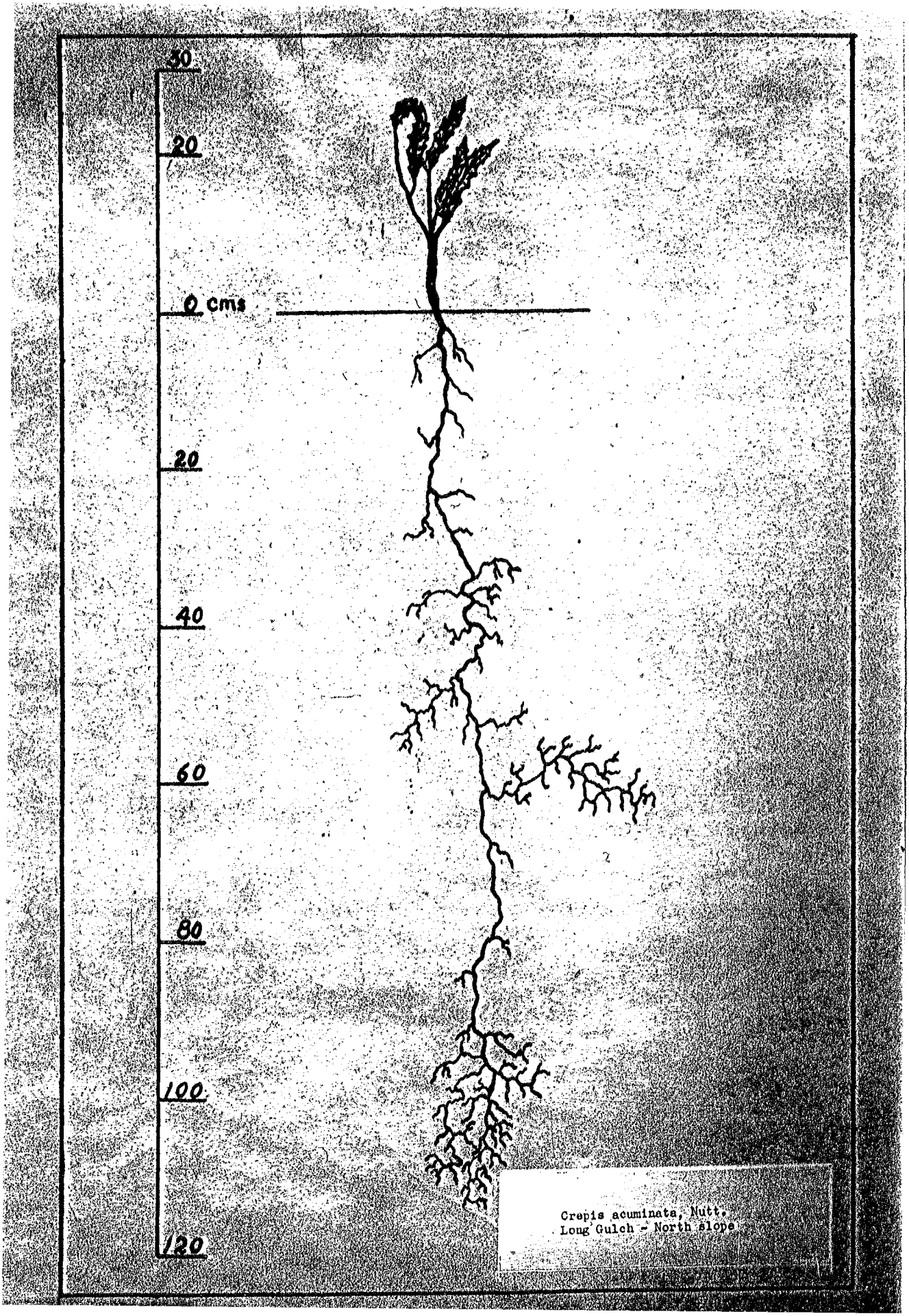
Silene sp.
Long Gulch - North slope



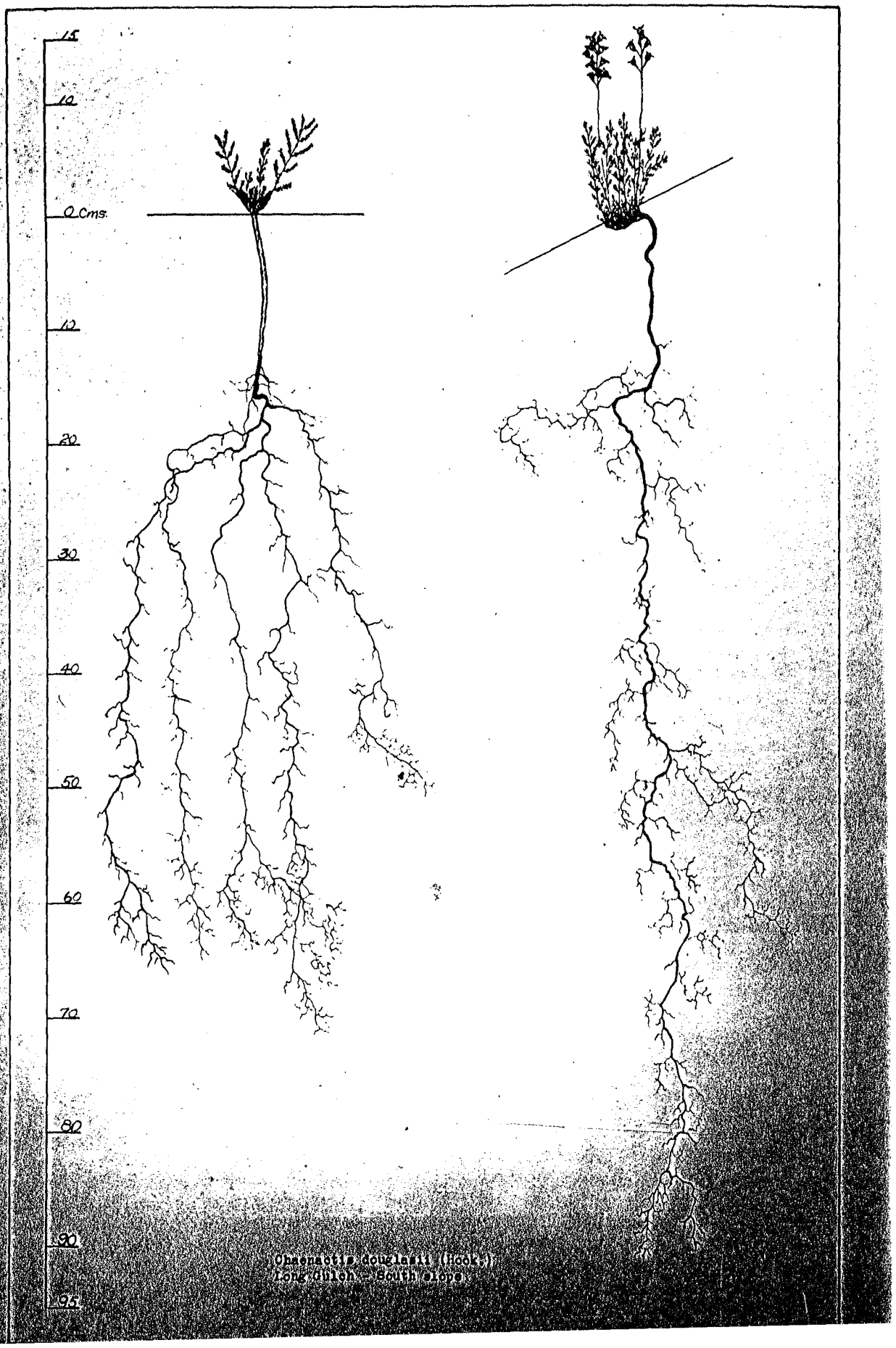
Spraguea nuda (Greene) Howell
Trinity Ridge - East slope



Aplopappus lanugenosus, A. Gray
Long Gulch - South slope



Crepis acuminata, Nutt.
Long Gulch - North slope

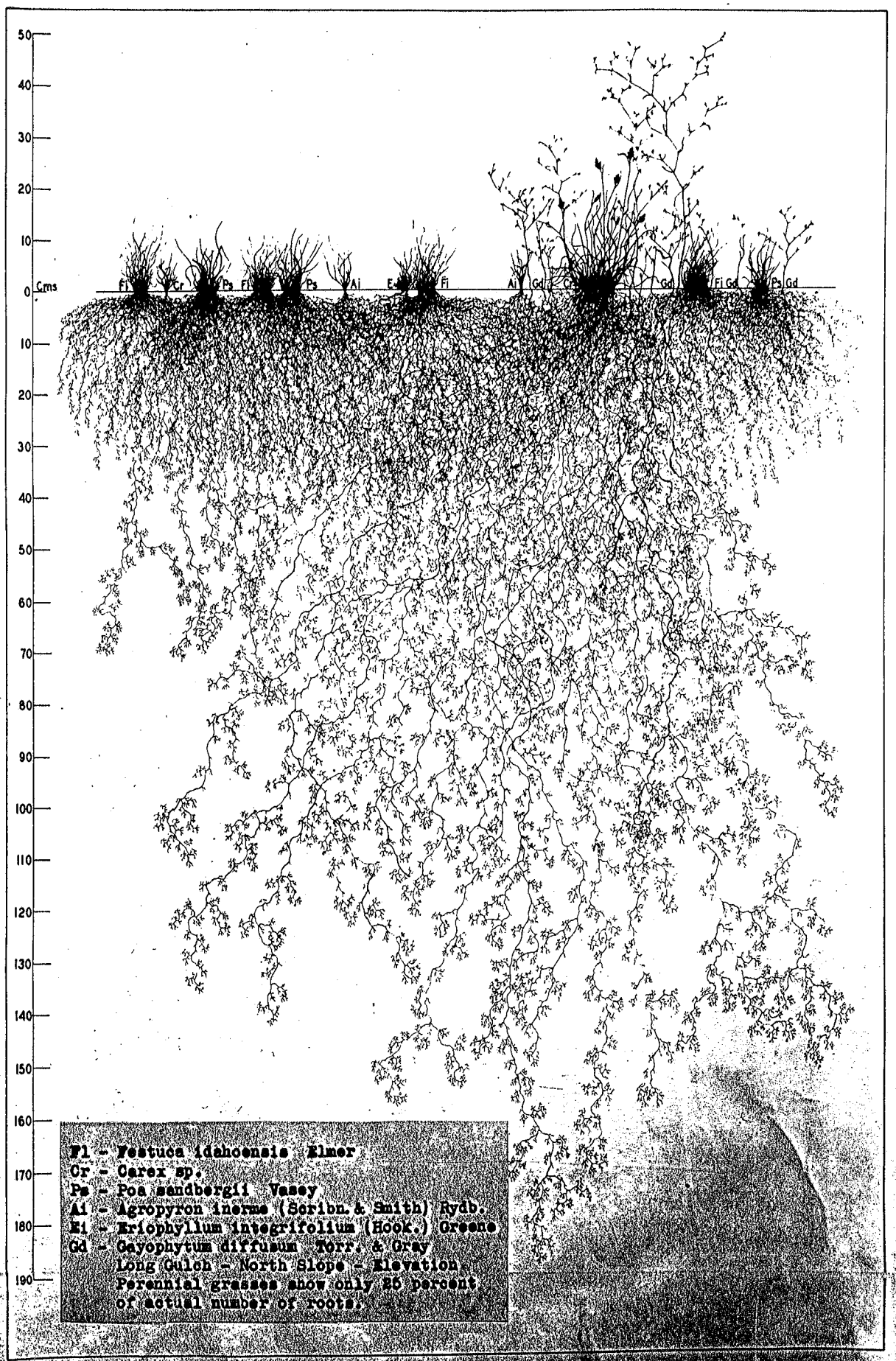


Chaenactis douglasii (Hook.)
Long Gulch - South slope

In order to study root systems of the plant communities of different successional stages bisects were made on each area having a distinct vegetational type. Only two bisects representing the two extreme vegetational types on the Boise River watershed (the grass-sedge climax type and the first invader or annual weed type) are included in the catalog.

The grasses and sedges of the climax type are growing in close association, the clumps being only 20 to 30 cms apart. Their root systems compete for moisture and plant nutrients in the upper 20 to 30 cms of soil and form a barrier against erosion that has provided adequate protection to the soil of this well managed area. The root systems of each species of plants extend through a relatively different soil horizon however, Poa secunda and Festuca idahoensis have a widespreading system that does not penetrate much below about 40 cms. Agropyron inerme roots have less lateral spread by penetrate to a depth of 60 cms while the root system of Carex geyeri occupies the soil horizon far below that of any plant in the climax type. Thus the soil systems have a minimum amount of competition and can thrive in close association, producing a very effective obstruction against any form of erosion.

Overgrazing and erosion have so depleted the area represented by the first invader type bisect that only a few relicts of the former vegetation have survived, Agropyron inerme and Balsamorhiza sagittata. The annual weeds and the annual grass, Bromus tectorum, that have come in on the area furnish little resistance to the eroding away of the surface layer of soil due to their shallow fibrous or taproot system and their infrequency of occurrence over the area.


50
40
30
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10
0 Cms
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40
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70
80
90
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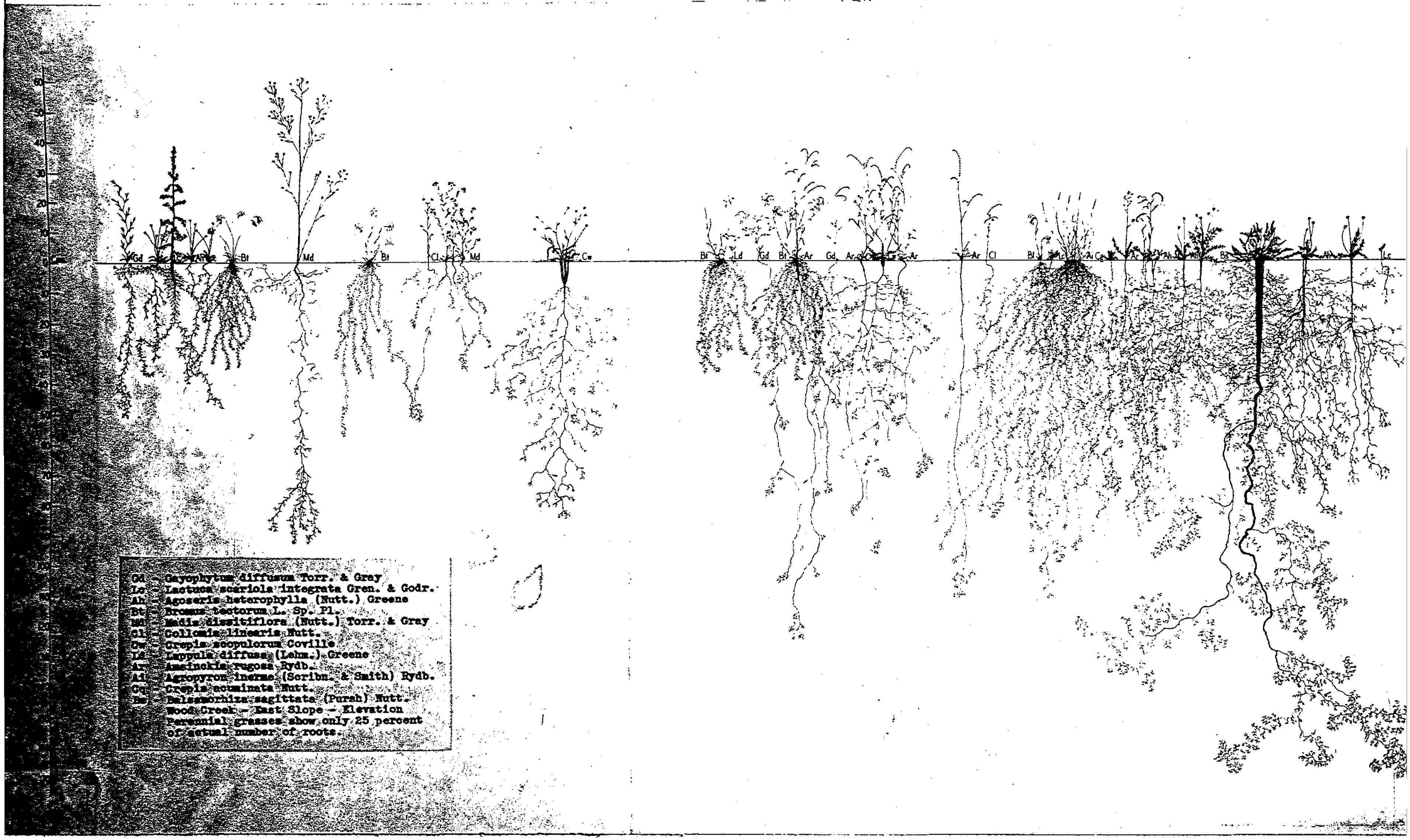
110
120
130
140
150
160
170
180
190
Fl
Cr
Ps
Fl
Ps
Ai
Ei
Fl
Ai
Gd
Cr
Gd
Fl
Gd
Ps
Gd
Fl - Festuca idahoensis Elmer
Cr - Carex sp.
Ps - Poa sandbergii Vasey
Ai - Agropyron inerme (Scribn. & Smith) Rydb.
Ei - Eriophyllum integrifolium (Hook.) Greene
Gd - Gayophytum diffusum Torr. & Gray
Long Gulch - North Slope - Elevation.
Perennial grasses show only 25 percent
of actual number of roots.



Gd - Gayophytum diffusum Torr. & Gray
Lc - Lactuca scariola integrata Gren. & Godr.
Ah - Agoseris heterophylla (Nutt.) Greene
Bt - Bromus tectorum L. Sp. Pl.
Md - Madia dissitiflora (Nutt.) Torr. & Gray
Cl - Collomia linearis Nutt.
Cw - Crepis scopulorum Coville
Ld - Lappula diffusa (Lehm.) Greene
Ar - Amsinckia rugosa Rydb.
Ai - Agropyron inerme (Scribn. & Smith) Rydb.
Ca - Crepis acuminata Nutt.
Bs - Balsamorhiza sagittata (Pursh) Nutt.
Wood Creek - East Slope - Elevation
Perennial grasses show only 25 percent
of actual number of roots.